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Grade 12 Examinations - 1967

Mrs H. A. Sutton

ONTARIO DEPARTMENT OF EDUCATION

GRADE 12 DEPARTMENTAL EXAMINATIONS, 1967

APPLIED ELECTRICITY

TIME — 2 HOURS

Note 1. *The Presiding Officer will place both Part A (which includes diagram sheets to be used in answering Questions 3, 4, and 5) and Part B on your desk at the beginning of the examination period. Part B, to which 25 marks will be allotted, may be answered at any time during the examination period.*

Note 2. *Your name and form, and the name of your school are to be written clearly on each examination book, at the top of Part B, and on each diagram sheet.*

Note 3. *You should obtain a book of mathematical tables, if required, from the Presiding Officer.*

Note 4. *Geometry instruments and slide rules may be used.*

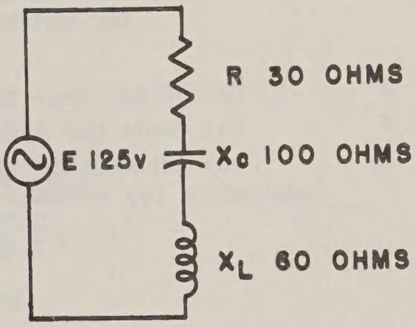
PART A

SECTION I

Answer any FOUR questions in Section I.

Values

1. (*a*) An inductance coil of negligible resistance, a capacitor, and a resistor are connected in series to a 125-volt a-c supply as shown.



Calculate *each* of the following.

1 (i) the circuit current
2 (ii) the circuit impedance
1 (iii) the voltage across the resistor
1 (iv) the voltage across the capacitor
1 (v) the voltage across the inductance coil
1 (vi) the true power
1 (vii) the circuit power factor

4 (*b*) Draw a vector (phasor) diagram approximately to scale, for the circuit shown above. Mark the values on all voltage and current vectors and mark the value on the phase angle.

6 2. (*a*) Draw a schematic diagram for a Wheatstone bridge circuit. Label all the main parts.

2 (*b*) State the equation for the Wheatstone bridge circuit in a balanced condition.

4 (*c*) Explain how the bridge may be used to determine the resistance of an unknown resistor. (Assume the necessary values).

3. Three single-phase transformers are used to supply a three-phase four-wire distribution system with electrical energy at 120/208 volts. The transformer bank has a rating of 200 kVA and is supplied by a 4160-volt, three-phase line.

6 (*a*) Complete the accompanying diagram showing the primary and secondary windings connected in star-star and connected to the supply and secondary lines. A fully grounded system is to be used. Mark the values for all line and phase (line to neutral) voltages.

4 (*b*) Calculate the input line currents and the output line currents for the above transformer bank operating at rated capacity and supplying 200 kVA to a load whose power factor is 90%.

2 (*c*) What is the advantage of using a four-wire 120/208-volt three-phase system, rather than a three-wire three-phase system, to supply a small factory.

12 4. Complete the wiring diagram for the motor control circuit on the accompanying sheet. The purpose of the selector switch is to provide the option of either automatic operation from a two-wire control device (e.g. pressure switch) or hand control from a start-stop station.

CONTINUED OVER⟶

Values

5 5. (*a*) Complete the internal connections of the split-phase motor diagram shown on the accompanying sheet. Each coil indicates a pole winding.

2 (*b*) State how this motor may be reversed.

2 (*c*) Explain the purpose of the centrifugally operated starting switch.

3 (*d*) From careful examination of the information contained in the diagram, determine the synchronous speed for the motor if the motor is connected to a supply of 60 cycles per second.

SECTION II

Answer EITHER Question 6 OR 7 in Section II.

either

6. (*a*) Draw a schematic diagram to show how a D'Arsonval type galvanometer may be used in conjunction with an external resistance to measure *each* of the following.

2×2 (i) d-c voltage (ii) d-c current

(*b*) This galvanometer is rated at 50 millivolts and 2 milliamperes (full-scale deflection). Calculate *each* of the following.

3 (i) the resistance of the external resistor referred to in (*a*) (i), if the instrument is to have a full-scale deflection of 150 volts d-c.

2 (ii) the voltage drop across the external resistor referred to in (*a*) (i), when the instrument indicates 150 volts.

or

3 7. (*a*) Name *three* types of power loss in a-c motors.

3 (*b*) State the reason for *each* of the losses given in your answer to (*a*).

3 (*c*) Identify the motor part or parts in which *each* of the losses given in your answer to (*a*) occurs.

SECTION III

Answer any TWO questions in Section III.

2 8. (*a*) Give *two* reasons why it is often desirable to limit the starting current in large three-phase squirrel-cage induction motors.

3 (*b*) List *three* different types of starters which may be used to start large three-phase squirrel-cage induction motors.

5 9. An electrician is called to "troubleshoot" a 550-volt, three-phase, 5 hp motor circuit. It consists of a squirrel-cage induction motor, a fused disconnect switch, a magnetic "across-the-line" starter, and a single "start-stop" station. The only information available is that the motor fails to start when the start button is pressed. Assuming that the motor circuit is correctly wired, list *five* faults that might cause the motor to fail to start.

5 10. State *five* reasons why excessive sparking at the brushes may occur in a d-c motor operating at rated load.

SECTION IV

Answer EITHER Question 11 or 12 in Section IV.

either

5 11. (*a*) Draw a schematic diagram for a full-wave rectifier circuit that uses two diodes and supplies a load. The rectifier circuit is to include a filter system. Label all the main parts.

3 (*b*) Draw a diagram for *each* of the following.

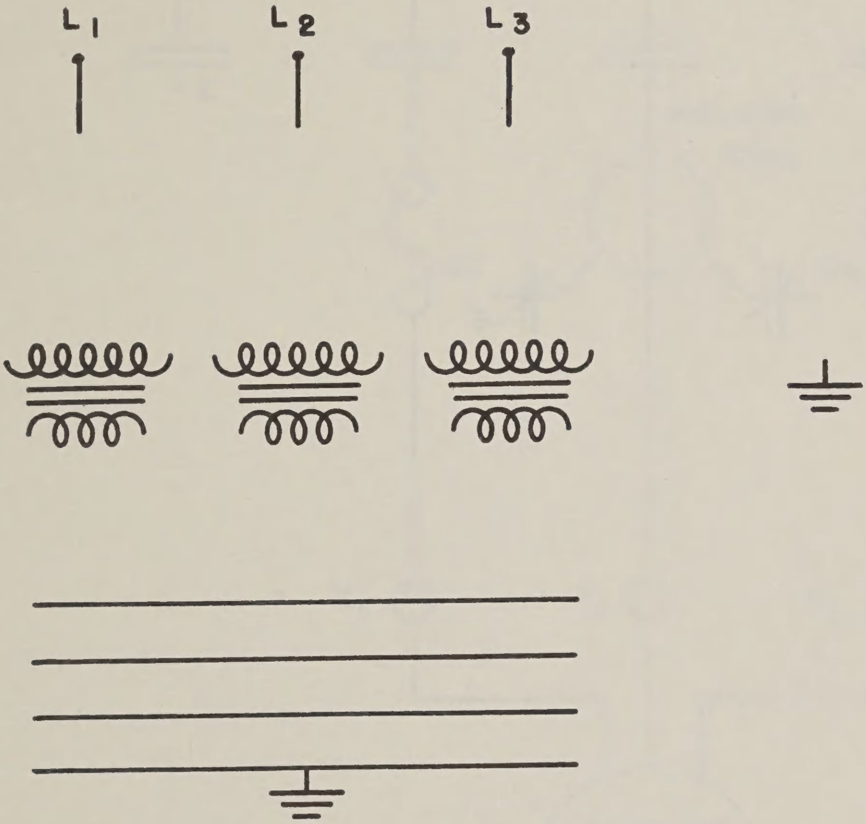
(i) the voltage waveform of the a-c source
(ii) the voltage waveform at the input to the filter
(iii) the voltage waveform at the load.

or

6 12. (*a*) Name *three* advantages of transistors compared to conventional vacuum tubes.

2 (*b*) Name *two* parts of a transistor.

To be used in answering Question 3.

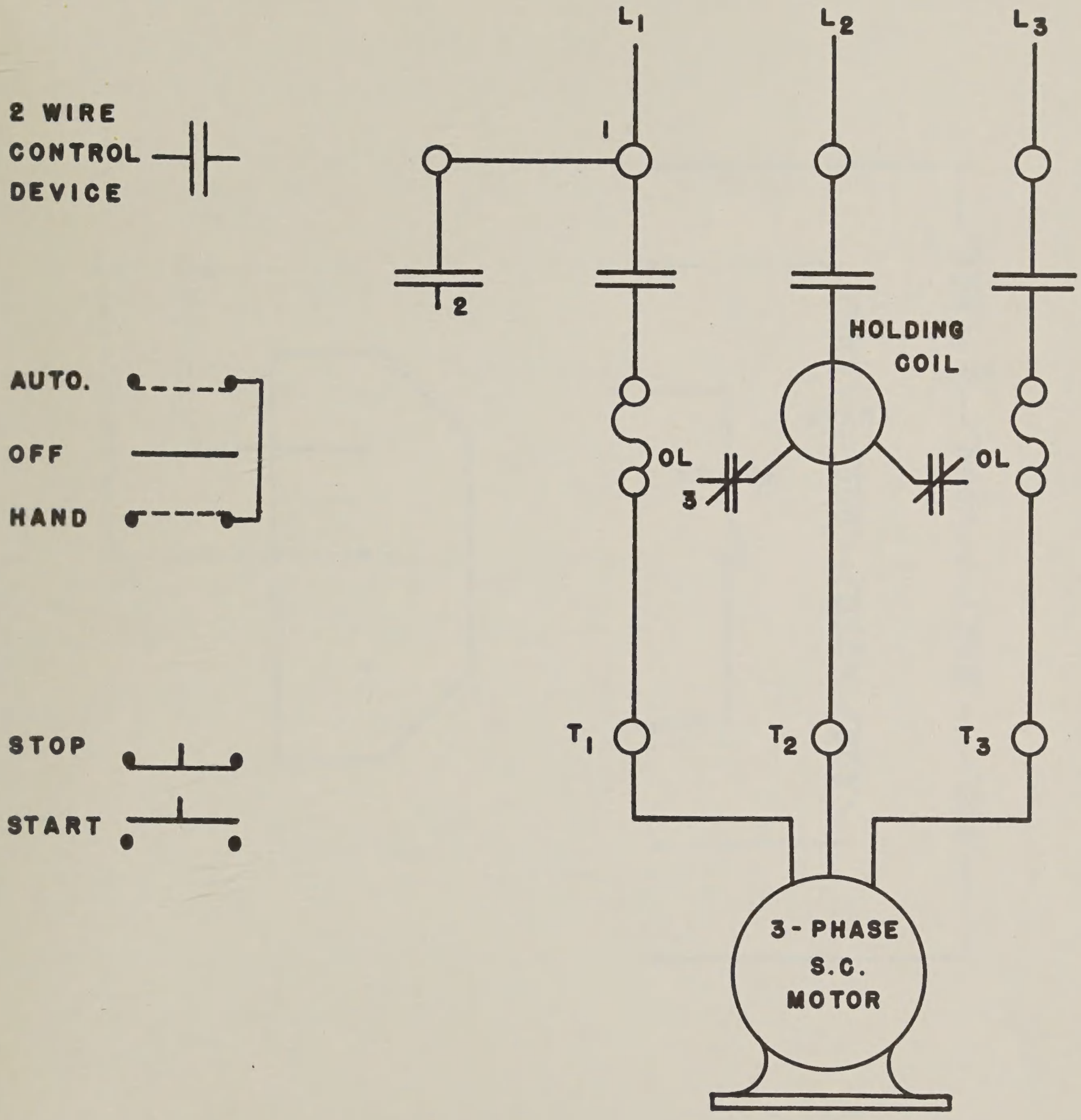


NAME ....

FORM ....

SCHOOL ....

To be used in answering Question 4.

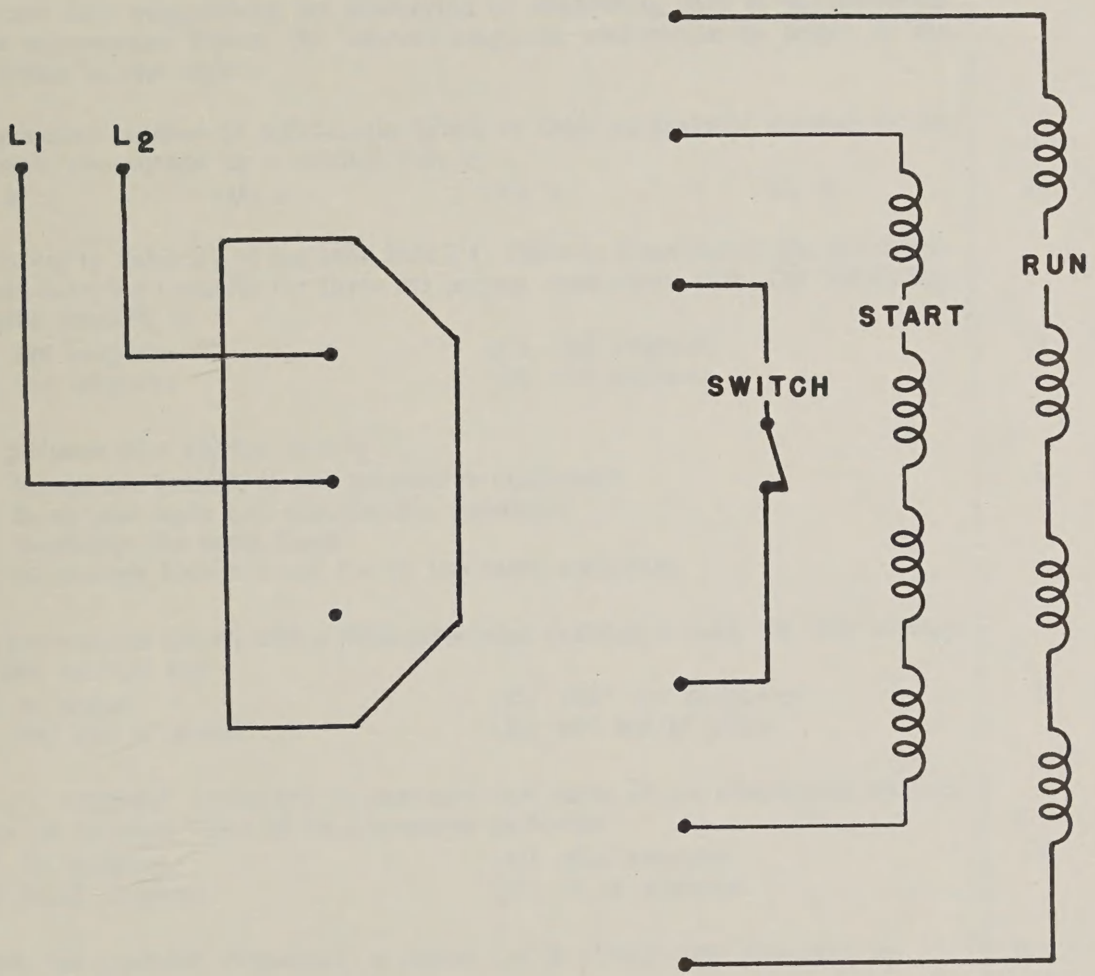


NAME ....

FORM ....

SCHOOL ....

To be used in answering Question 5.



NAME ....

FORM ....

SCHOOL ....

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ONTARIO DEPARTMENT OF EDUCATION

GRADE 12 DEPARTMENTAL EXAMINATIONS, 1967

APPLIED ELECTRICITY

PART B

. . . .
NAME

. . . .
FORM

. . . .
NAME OF SCHOOL

NOTE 1. *Part B has a value of 25 marks and all items are equal in value.*

NOTE 2. *Answers are to be clearly indicated in the column at the right.*

— — — —

There are four suggestions for answering or completing each of the following incomplete statements. Select the correct response, and circle its *letter* in the answer column at the right.

1. The greatest number of right-angle bends or their equivalents allowed by the Code between two outlets in a conduit run is

(A) 6 (B) 3 (C) 4 (D) 5

1. A B C D

2. According to Table #2 of the 1963 H.E.P.C. Ontario Electrical Code, the allowable current-carrying capacity for three #0 copper conductors with TW insulation, in a metallic conduit, is

(A) 125 amperes
(B) 110 amperes
(C) 145 amperes
(D) 120 amperes

2. A B C D

3. The purpose of a splitter box is

(A) to enclose branch circuit protective equipment
(B) to enclose main and distribution terminals
(C) to enclose the main fuses
(D) to provide both a-c and d-c in the same enclosure

3. A B C D

4. In a three-phase circuit with a delta-connected resistance load, the line voltage and the line current are

(A) in phase
(B) 60° out of phase
(C) 120° out of phase
(D) 30° out of phase

4. A B C D

5. An a-c ammeter connected to measure the value of an alternating current which has an average value of 20.0 amperes indicates

(A) 20 amperes
(B) 28.28 amperes
(C) 22.2 amperes
(D) 14.14 amperes

5. A B C D

6. Below the resonant frequency, a series L-C-R circuit acts similarly to

(A) an inductance and resistance in series
(B) a capacitor and resistor in series
(C) a pure resistance
(D) a reluctance

6. A B C D

7. The control circuit in an "across-the-line" three-phase starter is supplied by

(A) pulsating d-c
(B) three-phase a-c
(C) direct current
(D) single-phase a-c

7. A B C D

8. If the load is removed from a large d-c series motor, the speed will

(A) remain the same
(B) decrease considerably
(C) increase considerably
(D) decrease gradually

8. A B C D

CONTINUED OVER→

9. A method of reversing a single-phase repulsion-start induction motor is to

(A) change the brush position
(B) interchange the starting leads
(C) interchange two rotor leads
(D) interchange two stator leads

9. A B C D

10. A transformer designed for a 120-volt supply has a 300-turn primary winding. If the secondary winding is designed for 720 volts, it has

(A) 360 turns
(B) 720 turns
(C) 1800 turns
(D) 50 turns

10. A B C D

11. A three-phase 12-pole squirrel-cage induction motor is connected to a supply of 550 volts, 60 cycles per second. The approximate speed under normal load will be

(A) 10 RPS
(B) 850 RPM
(C) 570 RPM
(D) 19 RPS

11. A B C D

12. A device which is used to prevent a flow of direct current and which appears to pass alternating current is called

(A) an inductor
(B) a capacitor
(C) a rectifier
(D) an inverter

12. A B C D

13. In a domestic consumer's service the ground connection from the service disconnect switch box is made to

(A) the street side of the water meter
(B) the nearest hot water pipe
(C) the house side of the water meter
(D) the nearest cold water pipe by soldering

13. A B C D

14. The term "single-phasing" refers to a three-phase circuit where

(A) one fuse is "blown"
(B) two fuses are "blown"
(C) a shunt motor will not start
(D) the voltages are unbalanced

14. A B C D

15. A semiconductor diode is often used as a rectifier because

(A) it offers a low resistance path in either direction
(B) it offers a low resistance path in one direction only
(C) electrons are controlled by the grid
(D) of the Zener effect

15. A B C D

16. In domestic wiring the neutral conductor

(A) must be fused
(B) must be connected to each switch
(C) must be connected to the identified terminal of every lighting fixture
(D) must be grounded at every box

16. A B C D

17. Transformer cores are laminated to reduce

(A) copper loss
(B) hysteresis loss
(C) transformer overload
(D) eddy currents

17. A B C D

18. The current rating of a relay used to protect an a-c motor with a rated current of 5 amperes is

(A) 7.5 amperes
(B) 5.0 amperes
(C) 6.25 amperes
(D) 15.0 amperes

18. A B C D

19. When an alternating current with a maximum value of 10 amperes is passed through a 10-ampere d-c ammeter, the ammeter indicates

(A) 7.07 amperes
(B) 0 amperes
(C) 8.66 amperes
(D) 6.37 amperes

19. A B C D

20. In a series L-C-R circuit, the sum of voltmeter readings taken across the individual components is

(A) equal to the applied voltage
(B) less than the applied voltage
(C) greater than the applied voltage
(D) equal to the impedance drop

20. A B C D

21. To measure resistance with a high degree of accuracy, one should use
(A) a Wheatstone bridge
(B) an ohmmeter
(C) a wattmeter
(D) a "megger"

21. A B C D

22. The value of the multiplier used to extend the range of an 0-100 volt (1000 ohms per volt) d-c voltmeter to 500 volts is
(A) 500,000 ohms
(B) 100,000 ohms
(C) 40,000 ohms
(D) 400,000 ohms

22. A B C D

23. If an electric clock with a motor designed to operate on 120 volts, 60 cycles per second is connected to a source of 120 volts, 50 cycles per second, the clock will
(A) stop
(B) run slow
(C) gain time
(D) burn out

23. A B C D

24. The main function of the filter unit in a power supply is to
(A) increase the output voltage
(B) smooth out the a-c ripple
(C) protect the rectifier tube from an overload
(D) supply various voltages

24. A B C D

25. A 20 microfarad and a 30 microfarad capacitor are connected in series. The combined capacitance equals
(A) 12 microfarads
(B) 10 microfarads
(C) 50 microfarads
(D) 25 microfarads

25. A B C D

ONTARIO DEPARTMENT OF EDUCATION

GRADE 12 DEPARTMENTAL EXAMINATIONS, 1967

APPLIED ELECTRONICS

TIME — 2 HOURS

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NOTE 2. *Your name and form, and the name of your school are to be written clearly on each examination book, and at the top of Part B.*

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Values

PART A

SECTION I

Answer ALL Questions in Section I.

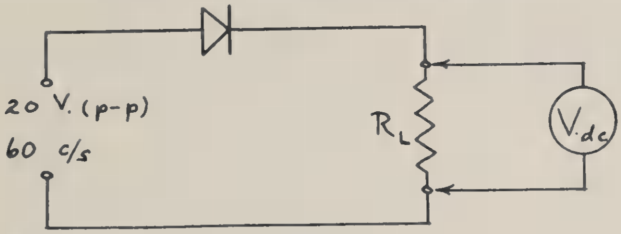


Fig. 1

10 1. A 20.0 V (p-p) 60 Hz (c/s) source is connected to a half-wave rectifier circuit as shown in Figure 1.

(*a*) Draw the voltage waveform that would appear across the resistor.

(*b*) What would be the maximum value, in volts, of this waveform (assume no losses elsewhere in the circuit)?

(*c*) What would be the voltage indication of an accurately calibrated d-c voltmeter connected across the resistor (assume no losses due to the application of the meter)?

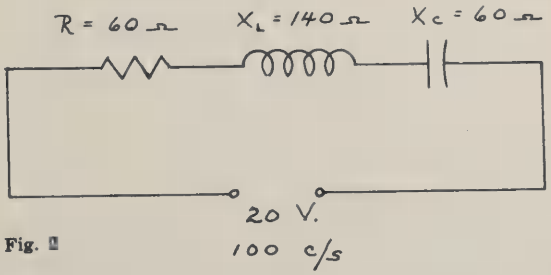


Fig. 2

12 2. A resistor is connected in series with a pure inductance and a pure capacitance as shown in Figure 2.

(*a*) What is the net reactance of the circuit?

(*b*) What is the impedance of the circuit?

(*c*) Calculate *either* the value of the inductance (L) *or* the value of the capacitance (C).

CONTINUED OVER⟶

Values

10 3. (*a*) Draw a simple diagram of a PN junction showing the polarity of the potential barrier which develops at the junction.

(*b*) Indicate the polarity of external voltage required to pass current through the junction.

(*c*) Explain briefly how N-type semi-conductor material differs from P-type semi-conductor material.

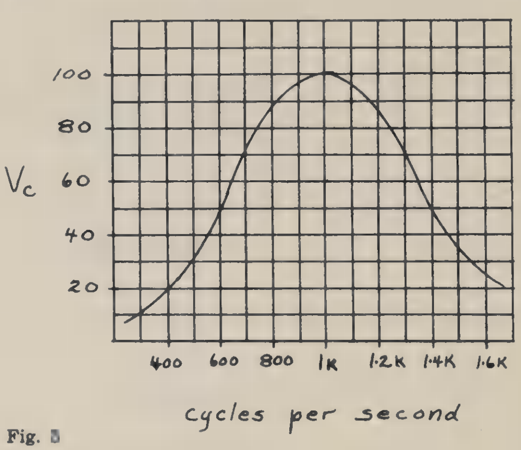


Fig. 3

10 4. The graph in Figure 3 shows the frequency response characteristic of a series resonant circuit.

(*a*) What is the frequency corresponding to each half-power point?

(*b*) What is the bandwidth, in cycles per second, of the circuit?

8 5. Name and define any *four* of the following as applied to transistors.

(*a*) V_{CE} (*b*) I_C (*c*) V_{EB} (*d*) I_{CEO} (*e*) I_{CBO}

SECTION II

Answer EITHER Question 6 OR 7 in Section II.

either

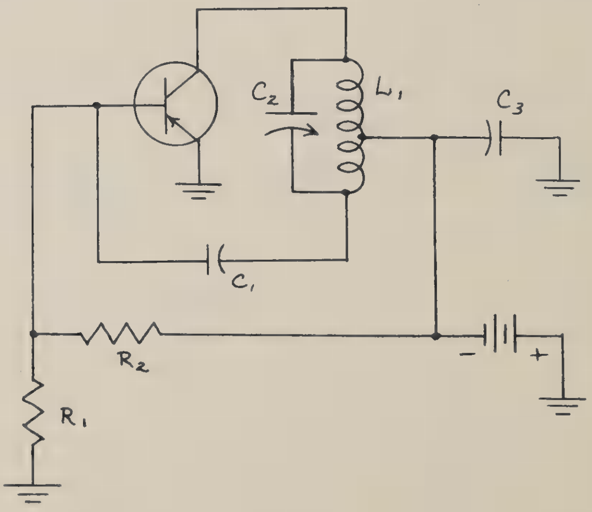


Fig. 4

10 6. The circuit in Figure 4 represents a Hartley r.f. oscillator.

(*a*) What type of transistor is used in this circuit?

(*b*) Why is a *variable* capacitor used for C_2?

(*c*) Why is capacitor C_1 used in this circuit?

(*d*) What purpose is served by the voltage divider formed by R_1 and R_2?

(*e*) Draw a simple sketch to show how the signal could be taken from the oscillator to feed another device such as an amplifier.

or

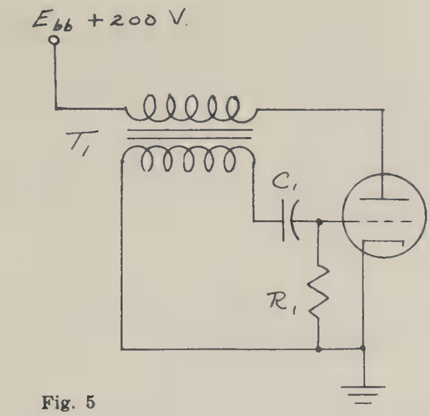


Fig. 5

10 7. The circuit in Figure 5 represents a single-swing blocking oscillator.

(*a*) Sketch two cycles of the voltage waveform that would appear at the plate of the tube.

(*b*) Sketch two cycles of the voltage waveform that would appear at the grid of the tube.

(*c*) What would be the effect on this oscillator, if the resistance of R_1 were decreased?

(*d*) What would be the effect on this oscillator, if the capacitance of C_1 were increased?

(*e*) Describe how you could use a d-c VTVM to determine whether this oscillator is operating.

SECTION III

Answer EITHER Question 8 OR 9 in Section III.

either

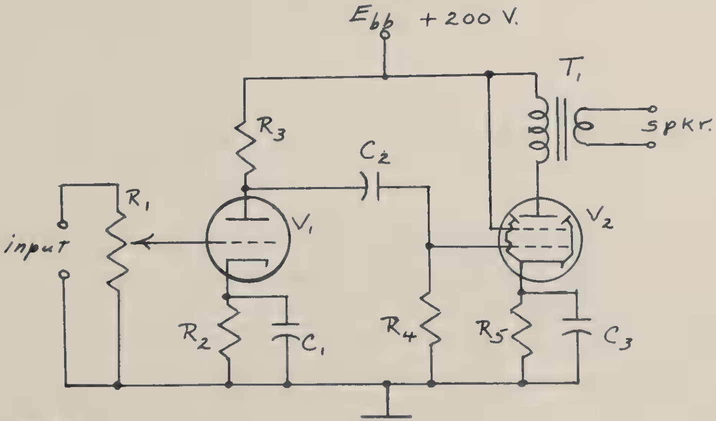


Fig. 6

10 8. The circuit in Figure 6 represents a two-stage audio amplifier.

(*a*) Name *each* stage of this amplifier and identify the function of *each* stage.

(*b*) State *one* fault that could account for a reading of 200 volts d-c on a voltmeter connected between the plate of V_1 and ground.

(*c*) Why are C_1 and C_3 included in this circuit?

(*d*) Give a name used to identify the resistor R_3.

(*e*) Why are R_2 and R_5 included in this circuit?

or

SECTION III CONTINUED OVER⟶

Values

10 9. (*a*) Sketch a family of static collector characteristic curves for an NPN junction transistor connected in the common emitter configuration. Label the vertical and horizontal axes and the curves with the appropriate electrical symbols and include typical values of voltage and current.

(*b*) Draw a load line on the curves which you have sketched in your answer to (*a*), and locate the line in a suitable position. Calculate the value of the resistance which is represented by the load line.

SECTION IV

Answer EITHER Question 10 OR 11 in Section IV.

either

10 10. (*a*) Draw a block diagram of a television receiver and label each block with its functional name.

(*b*) Mark on the block diagram the location of *each* of the following controls.

- (i) height
- (ii) horizontal linearity
- (iii) brightness
- (iv) contrast
- (v) volume

or

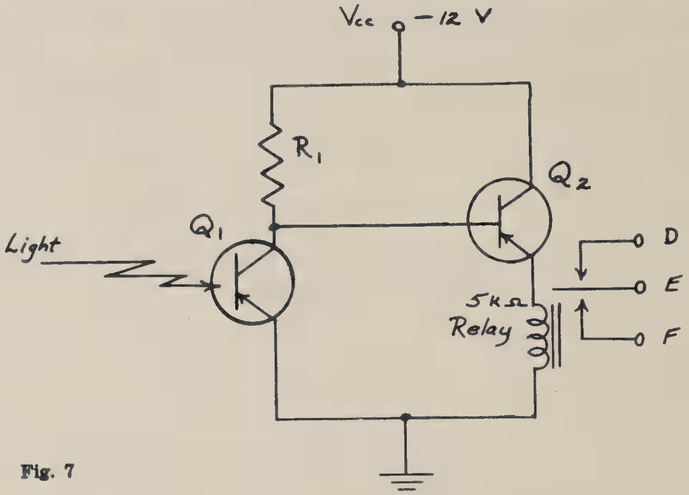


Fig. 7

10 11. The circuit in Figure 7 represents a light-operated relay.

(*a*) Name the device represented by the symbol Q_1.

(*b*) What is the purpose of the resistor R_1?

(*c*) Explain how the light intensity falling on Q_1 will control the base-emitter bias of the transistor Q_2.

(*d*) Explain how this circuit could be made adjustable for differences in ambient light conditions.

(*e*) Draw the relay terminals D, E, F on your answer paper and label them carefully. Show by means of a sketch how you would connect a lamp and an a-c source so that the lamp will operate when the light source is removed from Q_1.

ONTARIO DEPARTMENT OF EDUCATION

GRADE 12 DEPARTMENTAL EXAMINATIONS, 1967

APPLIED ELECTRONICS

PART B

....
NAME

....
FORM

....
NAME OF SCHOOL

Note 1. Part B has a value of 20 marks and all items are equal in value.

Note 2. Answers are to be indicated clearly in the answer column at the right.

There are five suggestions for completing each of the following incomplete statements. Select the correct response and circle its *letter* in the answer column at the right.

1. The oscillator frequency of a superheterodyne radio receiver tuned to 1,000 kHz (kc/s) is likely to be
   (A) 455 kHz (kc/s)
   (B) 910 kHz (kc/s)
   (C) 1,000 kHz (kc/s)
   (D) 1,455 kHz (kc/s)
   (E) 2,000 kHz (kc/s)

1.
A B C D E

2. The arrow head used in the symbol for a transistor represents the direction of
   (A) electron current in the emitter
   (B) "holes" or conventional current in the base
   (C) "holes" or conventional current in the emitter
   (D) majority carriers in the base
   (E) direction of minority carriers in the collector

2.
A B C D E

3. The screen-grid voltage of a typical pentode amplifier tube is
   (A) a large positive voltage varying greatly with the signal current
   (B) a small positive voltage similar in size to the cathode voltage
   (C) an amplified version of the input signal
   (D) a large negative voltage varying with the signal current
   (E) a large positive voltage with little or no variation

3.
A B C D E

4. A push-pull power amplifier stage requires
   (A) two identical input signals, equal in amplitude and 180 degrees out of phase
   (B) two input signals equal in amplitude and in phase
   (C) a single input signal
   (D) a step-up transformer connecting the power amplifier stage to the loudspeaker
   (E) a large value cathode resistor

4.
A B C D E

CONTINUED OVER→

5. In a parallel resonant circuit
(A) the line current is maximum and the circuit impedance is minimum
(B) the current and the individual voltage drops are maximum
(C) the line current is minimum and the circuit impedance is maximum
(D) the circuit impedance and the current are minimum
(E) the line current lags the source voltage by 90 degrees

5.
A B C D E

6. When two sine waves are 90 degrees out of phase,
(A) one tends to cancel out the effect of the other
(B) one has a positive peak while the other has a negative peak
(C) one has a positive peak while the other is at zero
(D) each has a positive peak at the same time
(E) the resultant wave form is in phase with the lagging waveform

6.
A B C D E

7. The chief disadvantage of a germanium transistor as compared with a vacuum tube is its
(A) operating life
(B) sensitivity to vibration
(C) size
(D) sensitivity to heat
(E) power consumption

7.
A B C D E

8. A 2.0 microfarad capacitor connected in *parallel* with a 1.0 microfarad capacitor will produce a combined capacitance of
(A) 0.33 microfarads
(B) 0.67 microfarads
(C) 1.0 microfarads
(D) 1.5 microfarads
(E) 3.0 microfarads

8.
A B C D E

9. A 15.9 microhenry coil will have an inductive reactance of 2,000 ohms at
(A) 1 kHz (kc/s)
(B) 10 kHz (kc/s)
(C) 20 kHz (kc/s)
(D) 20 MHz (Mc/s)
(E) 10 MHz (Mc/s)

9.
A B C D E

10. A basic 0 to 100 volt d-c voltmeter circuit contains
(A) a large value of resistance connected in series with the moving coil meter movement
(B) a small value of resistance connected in series with the moving coil meter movement
(C) a large value of resistance connected in parallel with the moving coil meter movement
(D) a small value of resistance connected in parallel with the moving coil meter movement
(E) no resistance except that of the moving coil meter movement

10.
A B C D E

11. An E.I.A. colour-coded resistor, coded red, violet, black, and gold, represents
(A) 27 ohms ± 5%
(B) 270 ohms ± 5%
(C) 270 ohms ± 10%
(D) 270 kohms ± 5%
(E) 470 kohms ± 10%

11.
A B C D E

12. The number 12 in the decimal system is represented in binary code as
(A) 0011
(B) 0012
(C) 1010
(D) 1100
(E) 1110

12.
A B C D E

13. The main purpose of interlaced scanning of a television image is to
(A) reduce flicker
(B) allow a greater number of lines to be shown
(C) shorten the picture height
(D) simplify the synchronizing circuits
(E) provide greater contrast in the picture

13.
A B C D E

14. The output of an automatic volume control (automatic gain control) circuit in a radio receiver is
(A) an a-c voltage proportional to the amplified signal
(B) an a-c voltage inversely proportional to the amplified signal
(C) a pulsating d-c voltage proportional to the amplified signal
(D) a pulsating d-c voltage inversely proportional to the amplified signal level
(E) a filtered d-c voltage proportional to the magnitude of the amplified i.f. signal level

14.
A B C D E

15. A power transformer rated for 120 volts a-c input is never connected to a source of 120 volts d-c because
(A) the transformer converts a-c to d-c
(B) it would produce excessive eddy currents
(C) the induced voltage could be excessive for the insulation of the windings
(D) there would be excessive primary current and the transformer would be damaged
(E) it would operate inefficiently

15.
A B C D E

16. The value of capacitance can be decreased by
(A) increasing the distance between the plates
(B) increasing the plate area
(C) increasing the dielectric constant
(D) increasing the capacitive reactance
(E) increasing the electrostatic field between the plates

16.
A B C D E

17. A rms voltage of 120 volts has a peak-to-peak value of
(A) 85 volts
(B) 160 volts
(C) 170 volts
(D) 240 volts
(E) 340 volts

17.
A B C D E

18. The stage which is found in a superheterodyne radio receiver but not in a tuned-radio-frequency (t-r-f) receiver is the
(A) r.f. amplifier
(B) mixer
(C) detector
(D) power amplifier
(E) power supply

18.
A B C D E

CONTINUED OVER →

19. One precaution that must be observed when an ohmmeter is used to check resistors in a circuit is to
   (A) start with the highest possible resistance range on the meter
   (B) keep the source voltage of the circuit below the voltage of the meter
   (C) determine the wattage of the resistor before attempting the measurement
   (D) disconnect paths in parallel with the measured resistance
   (E) observe the correct polarity of the ohmmeter leads

19.
A B C D E

20. The core of an audio frequency transformer is laminated to
   (A) reduce hysteresis losses
   (B) reduce eddy current losses
   (C) reduce saturation
   (D) reduce the induced voltage of the secondary winding
   (E) reduce the reflected impedance of the secondary winding

20.
A B C D E

ONTARIO DEPARTMENT OF EDUCATION

GRADE 12 DEPARTMENTAL EXAMINATIONS, 1967

COMBINED APPLIED ELECTRICITY AND APPLIED ELECTRONICS

TIME — 2 HOURS

NOTE 1. *The Presiding Officer will place both Part A and Part B on your desk at the beginning of the examination period. Part B, to which 20 marks will be allotted, may be answered at any time during the examination period.*

NOTE 2. *Your name and form, and the name of your school are to be written clearly on each examination book, and at the top of Part B.*

NOTE 3. *You should obtain a book of mathematical tables, if required, from the Presiding Officer.*

NOTE 4. *Geometry instruments and slide rules may be used.*

PART A

SECTION I.

Values

Answer any TWO questions in Section I.

11 1. A 20 ohm resistor and an inductor of unknown value are connected in series to a 115-volt, 25 Hz (c/s) supply. The current in the circuit is 4.6A. Calculate the inductance. (Consider the inductor to have negligible resistance.)

11 2. (*a*) State the formula for calculating resonant frequency of a L-C-R circuit.

(*b*) Draw the current response curve for a parallel L-C-R circuit. Extend the curve well beyond resonance in both directions. Label the horizontal and vertical axes and indicate the resonant point.

(*c*) Draw the impedance response curve for a series L-C-R circuit. Extend the curve well beyond resonance in both directions. Label the horizontal and vertical axes and indicate the resonant point.

11 3. (*a*) Sketch a schematic diagram for a Wheatstone bridge circuit.

(*b*) Explain how you would recognize a balanced condition when using the bridge.

(*c*) By referring to the diagram in (*a*), describe a circuit condition which will produce balance in the bridge. A mathematical statement may be used for your answer.

SECTION II.

Answer any TWO questions in Section II.

9 4. A single phase induction motor is connected to a 120-volt, 60 Hz (c/s) supply. The reactive component of motor current is 4A. Calculate the capacitance which must be connected to the motor terminals to raise the power factor to unity.

9 5. The line current of a delta-connected load is 30A. The three-phase line voltage is 200V and the power of each phase is 2000W. Calculate the circuit power factor.

9 6. A resistance of 30 ohms, an inductive reactance of 40 ohms, and a capacitive reactance of 20 ohms are connected in parallel to a 120-volt a-c supply.

(*a*) Calculate *each* of the following.

- (i) the branch currents
- (ii) the line current

(*b*) Draw, approximately to scale a complete vector diagram (phasor diagram) to represent the circuit conditions. Mark all current and voltage values on the appropriate vectors (phasors).

9 7. A four-pole, 60 Hz (c/s), three-phase induction motor has a full-load slip of 5 per cent. Calculate the rotor speed.

CONTINUED OVER→

Values

SECTION III.

Answer any TWO questions in Section III.

12 8. (*a*) Draw a schematic circuit diagram showing how a vacuum phototube (photoemissive) can produce an output voltage when a source of light is directed towards the photocathode.

(*b*) Explain the action that will occur in the circuit as a result of an increase of light directed towards the phototube.

12 9. Draw a schematic diagram for a complete single stage common-emitter amplifier that uses a NPN junction transistor. A single battery and bias stabilization are to be used in the circuit. Show both input and output coupling methods.

12 10. (*a*) Explain briefly the principle of heterodyne action in the superheterodyne receiver.

(*b*) Calculate the image frequency for a superheterodyne broadcast-band receiver tuned to an input r.f. signal of 800 kHz (kc/s). The intermediate frequency for the receiver is 455 kHz(kc/s).

(*c*) What is the intermediate frequency used in the i.f. sound channel of a modern television receiver?

(*d*) Name the type of modulation employed in the i.f. sound channel of a modern television receiver.

12 11. (*a*) Sketch a family of static collector characteristic curves for a NPN junction transistor connected in the common emitter configuration. Label the vertical and horizontal axes and the curves with appropriate electrical symbols and include typical values of voltage and current.

(*b*) Draw a load line on the curves sketched for (*a*). Use any placement which is convenient for the set of curves drawn. Calculate the value of the resistance which is represented by the load line.

(*c*) Mark on the diagram a suitable operating point for Class A operation.

SECTION IV.

Answer any TWO questions in Section IV.

8 12. (*a*) Give *two* reasons why it is often desirable to limit the starting current in large three-phase squirrel-cage induction motors.

(*b*) List *three* different types of starters which may be used to start large three-phase squirrel-cage induction motors.

(*c*) List *three* different types of single-phase induction motors.

8 13. An electrician is called to "troubleshoot" a 550-volt, three-phase, 5 hp motor circuit. It consists of a squirrel-cage induction motor, a fused disconnect switch, a magnetic "across-the-line" starter, and a single "start-stop" station. The only information available is that the motor fails to start when the start button is pressed. Assuming that the motor circuit is correctly wired, list *four* faults that might cause the motor to fail to start and state the remedy for each.

8 14. A 5 hp, 220-volt, three-phase, squirrel-cage induction motor is to be installed. The motor's name plate current is 15A. State *each* of the following.

(*a*) the current rating of the fuses required
(*b*) the current rating of the switch
(*c*) the size of conductors using type TW insulation
(*d*) the size of the rigid conduit
(*e*) the overload relay rating

ONTARIO DEPARTMENT OF EDUCATION

GRADE 12 DEPARTMENTAL EXAMINATIONS, 1967

COMBINED APPLIED ELECTRICITY AND APPLIED ELECTRONICS

PART B

....	NAME
....	FORM
....	NAME OF SCHOOL

NOTE 1. *Part B has a value of 20 marks and all items are equal in value.*
NOTE 2. *Answers are to be indicated clearly in the answer column at the right.*

— — — —

There are four suggestions for completing each of the following incomplete statements. Select the correct response and circle its *letter* in the answer column at the right.

1. An alternating current has a peak value of 20A. The average value is
(A) 14.14A (B) 12.74A (C) 10.0A (D) 7.07A

1. A B C D

2. The period of a sine wave having a frequency of 400 Hz (c/s) is
(A) 0.25 sec. (B) 0.125 sec. (C) 0.0025 sec. (D) 0.5 sec.

2. A B C D

3. In a series resonant circuit
(A) Z is maximum (C) R=Z
(B) I is minimum (D) R=O

3. A B C D

4. Two capacitors having a value of 0.1μF are connected in series. The total capacitance of the series combination is
(A) 0.2μF (B) 0.05μF (C) 0.5μF (D) 0.15μF

4. A B C D

5. When the line current of a parallel circuit on a-c is equal to the active current, the circuit power factor is
(A) 0.5 (B) 0.866 (C) 1.00 (D) 0.00

5. A B C D

6. In a star connection at unity power factor, the line voltage and line current are
(A) in phase (C) 30° out of phase
(B) 60° out of phase (D) 120° out of phase

6. A B C D

7. The relationship between the primary and secondary ampere-turns of a transformer is given by the expression
(A) $\frac{I_s}{T_s} = \frac{I_p}{T_p}$ (B) $\frac{I_p}{I_s} = \frac{T_s}{T_p}$ (C) $\frac{I_s}{T_p} = \frac{T_s}{I_p}$ (D) $\frac{I_p}{I_s} = \frac{T_p}{T_s}$

(NOTE. *The symbol T_s is equivalent to the symbol N_s and the symbol T_p is equivalent to the symbol N_p.*)

7. A B C D

8. Transformer cores are laminated to reduce
(A) copper losses (C) hysteresis losses
(B) eddy-current losses (D) manufacturing losses

8. A B C D

9. The addition of resistance to the rotor circuit of a three-phase wound-rotor induction motor, at starting, results in a
(A) reduction of rotor power factor (C) low value of starting torque
(B) high value of starting torque (D) decrease of rotor reactance

9. A B C D

CONTINUED OVER→

10. In a single-phase capacitor-start induction motor the main winding current and the starting winding current are, at starting, approximately

(A) 30° out of phase
(B) 90° out of phase
(C) in phase
(D) 180° out of phase

10. A B C D

11. To check whether an r.f. oscillator is operating, measure the

(A) resistance between the control grid and ground
(B) feedback voltage
(C) voltage across the screen dropping resistor
(D) bias at the control grid with a vacuum tube voltmeter

11. A B C D

12. A pentode operating as a Class A voltage amplifier with a sine wave input will conduct plate current for

(A) 180° of the input signal
(B) 360° of the input signal
(C) 120° of the input signal
(D) 40° of the input signal

12. A B C D

13. The correct colours for a 47K ohm carbon resistor with ± 5% tolerance are

(A) orange, violet, orange, gold
(B) yellow, violet, red, silver
(C) yellow, violet, orange, gold
(D) yellow, blue, orange, gold

13. A B C D

14. The peak inverse-voltage rating for a diode is defined as

(A) the maximum filament voltage
(B) the maximum positive voltage
(C) the maximum negative voltage across the load resistor
(D) the maximum negative voltage which can be applied to the anode with respect to the cathode

14. A B C D

15. The voltage measured at the plate of a triode used as a voltage amplifier in a R-C coupled system is found to be equal to the supply voltage E_{bb}. The output signal from this stage would be

(A) very high
(B) normal for the gain of the tube
(C) a little lower than normal
(D) zero

15. A B C D

16. The greatest number of right-angle bends or their equivalents allowed by the Code between two outlets in a conduit run is

(A) 6
(B) 3
(C) 4
(D) 5

16. A B C D

17. The purpose of a splitter box is

(A) to enclose branch circuit protective equipment
(B) to enclose main and distribution terminals
(C) to enclose main fuses
(D) to provide both a-c and d-c in the same enclosure

17. A B C D

18. The control circuit in an "across-the-line" three-phase starter is supplied by

(A) pulsating d-c
(B) three-phase a-c
(C) direct current
(D) single-phase a-c

18. A B C D

19. In a domestic consumer's service the ground connection from the service disconnect switch box is made to

(A) the street side of the water meter
(B) the nearest hot water pipe
(C) the nearest cold water pipe by soldering
(D) the house side of the water meter

19. A B C D

20. In domestic wiring, the neutral conductor

(A) must be fused
(B) must be connected to each switch
(C) must be connected to the identified terminal of every lighting fixture
(D) must be grounded at every box

20. A B C D

ONTARIO DEPARTMENT OF EDUCATION

GRADE 12 DEPARTMENTAL EXAMINATIONS, 1967

DRAFTING (MECHANICAL)

TIME — 2 HOURS

NOTE 1. *The Presiding Officer will place both Part A and Part B on your desk at the beginning of the examination period. Part B, to which 20 marks will be allotted, may be answered at any time during the examination period.*

NOTE 2. *Your name and form, and the name of your school, are to be written clearly on each examination book, and at the top of Part B.*

NOTE 3. *Geometry instruments and slide rules may be used.*

PART A

SECTION I, MACHINE DESIGN

Values

Answer Question 1 and any TWO of questions 2, 3, 4, 5 in Section I.

8 1. Define briefly *four* of the following terms.

- (*a*) coupling
- (*b*) cap screw
- (*c*) field weld
- (*d*) cam
- (*e*) detail drawing
- (*f*) left hand thread
- (*g*) keyway
- (*h*) boss

8 2. (*a*) Define the term, transition fit.

(*b*) A shaft is permitted to vary .003″ either way from a basic size of $2\frac{1}{4}''$.

- (i) Show the limits of this shaft on a dimension line as they should appear on a detail drawing.
- (ii) On a dimension line show *one other* acceptable method of dimensioning the shaft.

(*c*) A hole has limits of 1.000″ and 1.002″. The shaft which fits into this hole has a tolerance of .002″. Calculate the limits for the shaft if the allowance is +.001″.

8 3. Make a two-view sketch of simple parts, of your own choosing, which would require the type of section view for *each* of *four* of the following. (Show the cutting plane line in the correct position if required.)

- (*a*) an offset section
- (*b*) a removed section
- (*c*) a full section through a part with a web (the cutting plane line must pass through the web)
- (*d*) a half section
- (*e*) an aligned section

8 4. (*a*) Explain fully the meaning of the thread note $\frac{5}{8}$–11 UNC–2A.

(*b*) Determine the number of threads per inch for a screw thread having a pitch of .025″.

(*c*) State *two* of the three basic applications for screw threads.

8 5. Sketch a full-section view through a flanged coupling joining two shafts. Identify *two* important design features.

CONTINUED OVER→

Values

SECTION II, GEARING AND CAMS

Answer any TWO questions in Section II.

8 6. A gear which has a diametral pitch of 5 and rotates at 100 RPM meshes with a pinion which is to rotate at 180 RPM. If centre to centre distance must be held to 7.000″, calculate *each* of the following.

(*a*) pitch dia. of the gear
(*b*) outside dia. of the gear
(*c*) number of gear teeth

8 7. Using geometry instruments, draw a one-view full-size profile of a disc cam (plate cam) having the following specifications. (The profile may be done freehand. Do not erase construction work.)

follower motion
180° uniform rise of 1½″
180° uniform fall of 1½″
3″ base circle dia.
30°spacing for the profile

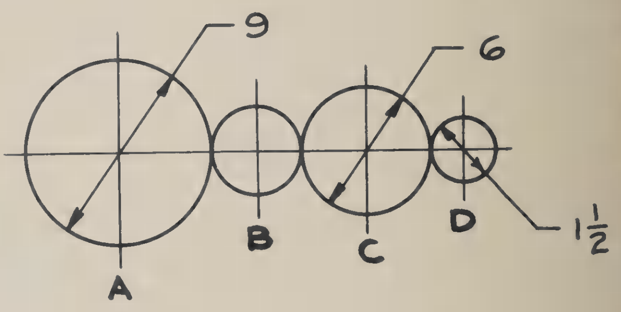
8 8. For the gear train shown, find

(*a*) the RPM of C if A rotates at 100 RPM,

(*b*) the number of teeth on B if D rotates at 600 RPM, B rotates at 200 RPM, and B has a diametral pitch of 10,

(*c*) the centre distance between A and D,

(*d*) the direction of the rotation of A if D has a clockwise rotation.



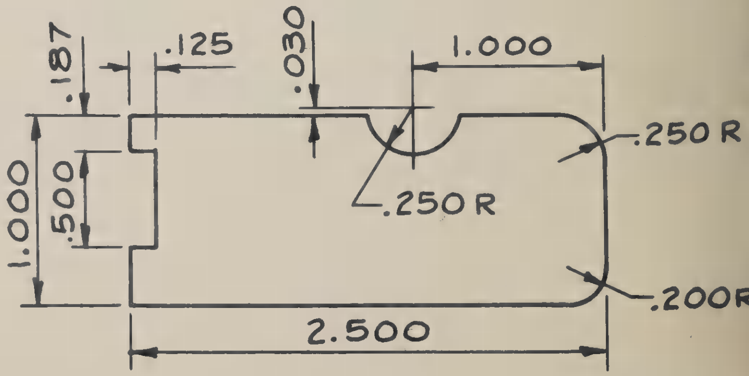
SECTION III, TOOL AND DIE DESIGN

Answer any TWO questions in Section III.

8 9. (*a*) List *four* steps in designing a simple drill jig.
(*b*) Name *two* types of drill bushings and state *one* advantage of *each*.

8 10. Make a one-view sketch *in section* of a typical progressive pierce and blank punch and die for a washer. On the sketch identify *eight* principal punch and die components. *Do not* show socket-head cap screws, dowels, guide pins or bushings for the die set.

8 11. The drawing at the right shows the die opening in the die block of a blanking punch and die. The die is to blank material .080″ thick. The cutting clearance is 5% per side. Make a sketch of the punch showing *eight* dimensions corrected for cutting clearance. Work to an accuracy of three decimal places.



Values

SECTION IV, STRENGTH OF MATERIALS

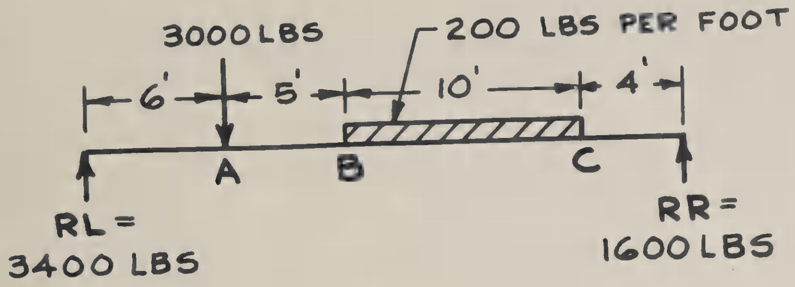
Answer any TWO questions in Section IV.

8 12. For the free-body diagram (loading diagram) shown, answer *each* of the following.

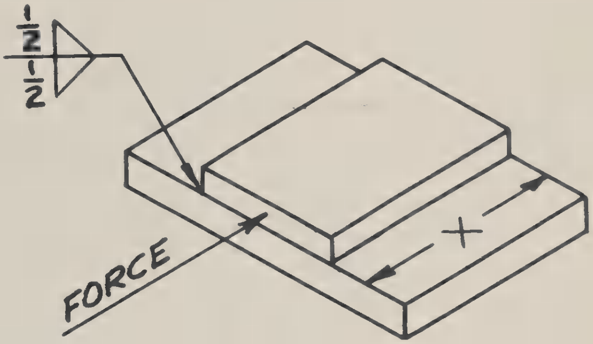
(*a*) Sketch a shear force diagram to approximate scale, showing shear force values at A, B and C.

(*b*) Determine the bending moment in foot pounds at the following positions

(i) point A (ii) point B



8 13. The two $\frac{1}{2}''$ fillet welds shown are to be sufficiently strong to carry a safe load of 34 tons. Find the minimum welded distance X that will safely carry the load. The allowable shear stress is 13,600 PSI. (The cosine of 45° is .707.)



8 14. A key having an allowable shear stress of 10,000 PSI is $\frac{1}{2}''$ wide. Calculate the length of the key required to transmit 24,000 inch pounds of torque if the key is to be used in a 4″ dia. shaft.

CONTINUED OVER→

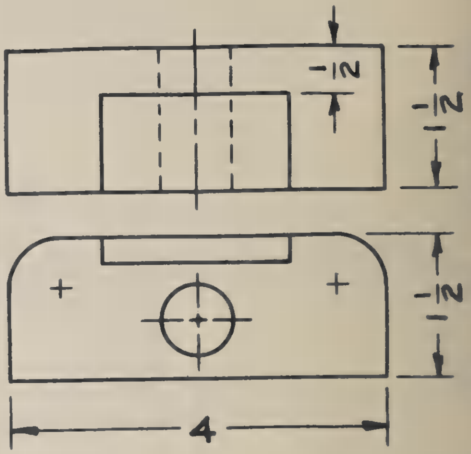
Values

SECTION V, PICTORIAL

Answer EITHER Question 15 OR 16 in Section V.

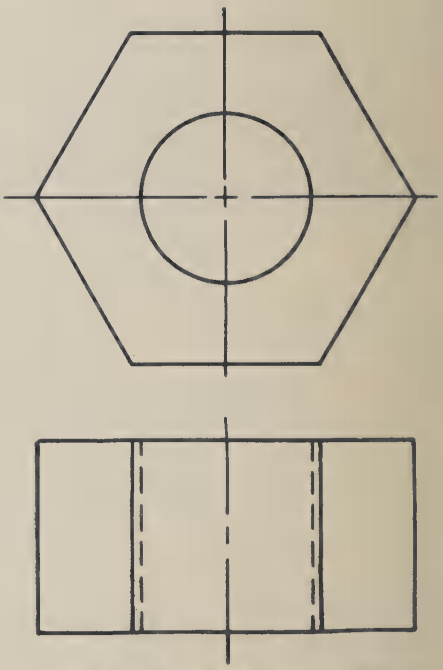
either

8 15. Using oblique cavalier projection, sketch the part shown to approximate full size. Sizes not shown on the sketch at the right should be proportioned approximately. Show object lines only.



or

8 16. Make a full-size isometric drawing of the part illustrated. Show object lines only. (*Do not erase construction lines.* Sizes may be scaled directly from the drawing.)



SCALE - FULL SIZE

ONTARIO DEPARTMENT OF EDUCATION

GRADE 12 DEPARTMENTAL EXAMINATIONS, 1967

DRAFTING (MECHANICAL)

PART B

....
NAME

....
FORM

....
NAME OF SCHOOL

NOTE 1. *Part B has a value of 20 marks and all items are equal in value.*

NOTE 2. *Answers are to be indicated clearly in the answer column at the right.*

— — — —

There are four suggested answers for each of the following questions or incomplete statements. Select the correct response, and circle its *letter* in the answer column at the right.

1. When the circular view of an internal thread is drawn to CSA standards
   (A) the major dia. is a hidden line
   (B) the minor dia. is an object line with a short break
   (C) the minor dia. is a hidden line
   (D) the major dia. is an object line with a short break

1. A B C D

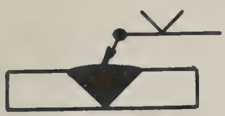
2. A bearing which is primarily designed for carrying loads parallel to the axis of the shaft is a
   (A) radial ball bearing
   (B) thrust ball bearing
   (C) radial roller bearing
   (D) tapered roller bearing

2. A B C D

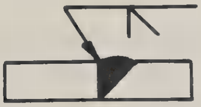
3. Which of the following welding symbols is correct if the weld is to be done in the shop?

3. A B C D

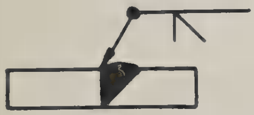
(A)



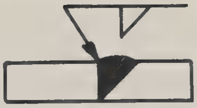
(C)



(B)



(D)



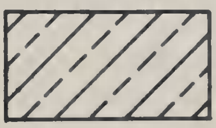
4. A fillet weld cannot be used on a
   (A) lap joint
   (B) butt joint
   (C) tee joint
   (D) corner joint

4. A B C D

5. The surface roughness number that could represent a sandcast surface is
   (A) 500 (B) 125 (C) 63 (D) 8

5. A B C D

6. Which of the following materials is indicated by the symbol shown?
   (A) cast iron
   (B) aluminum
   (C) steel
   (D) bronze



6. A B C D

7. The difference between the two limits of a dimension is called
   (A) clearance
   (B) allowance
   (C) interference
   (D) tolerance

7. A B C D

8. SAE 2330 nickel steel indicates
   (A) 33% nickel
   (B) 30% carbon
   (C) 3% nickel
   (D) 2% carbon

8. A B C D

CONTINUED OVER→

9. A full-depth spur gear having 40 teeth and a diametral pitch of 4 would have an outside dia. of

(A) 10.000″
(B) 10.250″
(C) 10.400″
(D) 10.500″

9. A B C D

10. The linear pitch on a rack corresponds to the term,

(A) diametrical pitch of the mating gear
(B) circular tooth thickness of the mating gear
(C) pitch dia. of the mating gear
(D) circular pitch of the mating gear

10. A B C D

11. A punch and die that completely pierces and blanks a part at one stroke of the punch press and at one station is called a

(A) simple die
(B) compound die
(C) progressive die
(D) multiple die

11. A B C D

12. A set block (setting block) is

(A) a hardened steel piece used to set cutter height on a fixture
(B) a metal slab on which a fixture rests
(C) a hardened steel piece on which the workpiece rests
(D) a hardened steel piece which locates the workpiece on a fixture

12. A B C D

13. If a punch and die having a cutting clearance of .002″ per side is to pierce a .594″ dia. hole in a part, the hole in the die block would have a dia. of

(A) .594″
(B) .598″
(C) .590″
(D) .596″

13. A B C D

14. A drill jig

(A) is clamped to the drill press table and does not guide the drill
(B) is never clamped to the drill press table and does not guide the drill
(C) is never clamped to the drill press table and does guide the drill
(D) may be clamped to the drill press table and does guide the drill

14. A B C D

15. A force which tends to shorten a test piece causes

(A) tensile stress
(B) shear stress
(C) compressive stress
(D) ultimate stress

15. A B C D

16. When a shear force diagram has one point of zero shear, this point represents

(A) the point where the bending moment is always zero
(B) the point where the bending moment is occasionally at maximum
(C) the point where the bending moment is occasionally zero
(D) the point where the bending moment is always at maximum

16. A B C D

17. The distance that a piece of metal 1″ long lengthens when its temperature is raised one degree is called

(A) ductility
(B) coefficient of linear expansion
(C) elasticity
(D) linear stress

17. A B C D

18. The ratio of the unit stress on a bar of material compared with the unit strain is called

(A) modulus of elasticity
(B) load
(C) total elongation
(D) elasticity

18. A B C D

19. The number shown in the V of a surface finish mark indicates

(A) the surface roughness height in microinches
(B) the waviness height of the surface
(C) the surface roughness height in decimals
(D) the width over which the roughness is measured

19. A B C D

20. The sheet metal development of a square to round sheet metal transition piece is done by

(A) radial line development
(B) parallel line development
(C) triangulation development
(D) straight line development

20. A B C D

ONTARIO DEPARTMENT OF EDUCATION

GRADE 12 DEPARTMENTAL EXAMINATIONS, 1967

INDUSTRIAL CHEMISTRY

TIME — 2 HOURS

NOTE 1. *The Presiding Officer will place on your desk at the beginning of the examination period the examination paper, a chart entitled 'Some Common Minerals' to be used in answering Question 12, and a graph-sheet to be used in answering Question 13.*

NOTE 2. *Your name, form, and the name of your school are to be written clearly on each examination book and on the graph-sheet for Question 13.*

NOTE 3. *You should obtain a book of mathematical tables, if required, from the Presiding Officer.*

NOTE 4. *Slide rules and geometry instruments may be used.*

Values

SECTION A

Answer FIVE questions in Section A.

12 1. (*a*) Give the main reason for using a dessicator in an analytical laboratory.

(*b*) Name *two* common dessicating agents.

(*c*) Give *two* significant reasons for digesting a precipitate.

(*d*) List *two* common filtration media used in an analytical laboratory.

(*e*) What *three* points concerning the condition of an analytical balance should be checked each time it is used?

12 2. With reference to the gravimetric method for the determination of chlorine in a water-soluble chloride, answer *five* of the following.

(*a*) In what way should the material supplied for analysis be conditioned before the samples are weighed?

(*b*) What are *two* reasons for forming the precipitate from a hot solution?

(*c*) Why should the precipitate and mother liquor be kept in the dark if filtration is not to be carried out for some time?

(*d*) State *two* reasons for using decantation as the method for separating most of the mother liquor from the precipitate.

(*e*) Give *two* reasons for adding a few drops of nitric acid to the wash liquid.

(*f*) What test is used to determine when the precipitate has been washed free of excess precipitating agent?

(*g*) What would be the most suitable precipitating agent if the gravimetric method referred to in this question were used for the gravimetric determination of silver ion?

12 3. A sample of steel was analysed for phosphorus by precipitating the phosphorus as magnesium ammonium phosphate, igniting the precipitate to magnesium pyrophosphate ($Mg_2P_2O_7$), and weighing it in this form.

The steel sample weighed 2.8416 g. and the ignited precipitate weighed 0.0108 g. Calculate the percentage of phosphorus in the steel sample.

(Atomic weight of phosphorus is 30.98; formula weight of magnesium pyrophosphate is 222.60.)

CONTINUED OVER⟶

Values

12 4. (*a*) Describe briefly a correct method of filling a buret with standardized hydrochloric acid up to the point where the initial reading is to be taken. The buret to be filled is clean, but wet with distilled water. (Labelled diagrams may be used to clarify your answer.)

(*b*) Give *two* requirements that must be fulfilled by a substance to make it suitable for use as a primary standard.

(*c*) Give a definition of a standard solution.

12 5. It is required to prepare 500 ml. of 0.100N sulphuric acid solution from stock sulphuric acid which contains 65.0% by weight H_2SO_4 and has a specific gravity of 1.50. For the preparation of the required solution, calculate *each* of the following.

(*a*) the number of gram-equivalent weights of H_2SO_4

(*b*) the weight of stock sulphuric acid

(*c*) the volume of stock sulphuric acid

(The formula weight of hydrogen sulphate is 98.08.)

12 6. (*a*) Explain the function of the potassium iodide in the preparation of a solution of iodine.

(*b*) Name one primary standard suitable for the standardization of a sodium thiosulphate solution.

(*c*) When is the correct time to add the starch indicator during the titration of an iodine solution with sodium thiosulphate solution?

(*d*) Would the apparent percentage of copper determined by an indirect iodine method be higher or lower than the correct percentage if the starch indicator was not added at the correct time? Briefly explain your answer.

(*e*) Potassium bromate can be used for the quantitative determination of arsenite ion by the reaction.

$$BrO_3^- + 3AsO_3^{3-} \rightarrow 3AsO_4^{3-} + Br^-$$

Calculate the gram equivalent weight of potassium bromate in this reaction if the formula weight of potassium bromate is 167.0.

SECTION B

Answer EITHER Question 7 OR Question 8 in Section B.

either

12 7. A 0.264 g. sample of an ore containing the mineral stibnite, Sb_2S_3, was dissolved in acid, the sulphide was removed to leave the antimony as Sb^{3+} and the solution was then diluted volumetrically to 250.0 ml.

A 25.0 ml. aliquot of the resulting solution required 25.23 ml. of 0.0104N potassium permanganate solution to oxidize all of the antimony from Sb^{3+} to Sb^{5+}.

Calculate the percentage of antimony in the ore sample.

(The atomic weight of antimony is 121.8)

or

12 8. A 2.67 g. sample of soda ash was dissolved in water and diluted volumetrically to 250.0 ml. A 25.0 ml. aliquot of this solution required 23.50 ml. of 0.100N hydrochloric acid for neutralization.

Calculate the percentage of sodium carbonate, Na_2CO_3, in the sample of soda ash.

(The formula weight of sodium carbonate is 106.0)

Values

SECTION C

Answer ONE of the three questions in Section C.

14 9. Calcium carbonate is used as a filler in the manufacture of coated papers. A sample of coated paper was submitted for a determination of calcium carbonate content by the ethylenediaminetetraacetic acid (EDTA) method.

The following data was obtained:

Standardization of EDTA Solution

— 0.261 g. of pure $CaCO_3$ was dissolved in hydrochloric acid and diluted volumetrically to 250.0 ml. with distilled water.

— the average of three titrations was 25.0 ml. of standard $CaCO_3$ solution $\equiv$ 27.8 ml. of EDTA solution.

Analysis of the paper

— a 4.17 g. sample of paper was reduced to ash, the ash dissolved in hydrochloric acid and the solution diluted volumetrically to 250.0 ml. with distilled water.

— the average of three titrations was 25.0 ml. of ash solution $\equiv$ 27.4 ml. of EDTA solution.

Calculate the percentage of calcium carbonate in the coated paper.

14 10. The manganese content of steel can be determined by oxidizing the manganese to permanganate ion, adding excess iron II sulphate solution to reduce the permanganate ion to manganese II ion, and then determining the amount of iron II sulphate in excess by titrating it against standard permanganate solution.

In such a determination the following data was obtained:

— weight of steel sample was 5.0000 g.,

— amount of iron II sulphate solution added was 20.00 ml. of 0.1000N solution,

— amount of permanganate solution required for titration of the excess iron II sulphate was 10.67 ml. of 0.0150N solution.

Calculate the percentage of manganese in the sample of steel.

(The atomic weight of manganese is 54.94)

14 11. A 0.4000 g. sample containing potassium hydroxide, potassium carbonate and inert impurities was dissolved in water and divided into two equal aliquots.

One aliquot was titrated with 0.1050N acid using phenolphthalein as the indicator and required 27.5 ml. of acid for titration.

The other aliquot was titrated with the same acid but with methyl orange as the indicator and required 31.5 ml. for titration.

Calculate the percentage of potassium hydroxide in the sample.

(The formula weight of potassium hydroxide is 56.11)

SECTION D

Answer ONE of the four questions in Section D.

14 12. (*a*) Select any *seven* of the minerals listed in the chart 'Some Common Minerals' which was supplied by the Presiding Officer and give the name of *each* one you have selected.

(*b*) From the list below select any *seven* minerals and give one economic use for each.

(i) feldspar
(ii) silica (quartz)
(iii) pentlandite
(iv) serpentine
(v) limestone
(vi) ilmenite
(vii) chalcopyrite
(viii) galena
(ix) argentite

CONTINUED OVER→

Values

14 13. (*a*) Define or describe *each* of the following terms as used in the paper industry.

(i) furnish
(ii) sizing
(iii) basis weight

(*b*) Give *one* type of paper which is manufactured from each of the following types of pulp.

(i) groundwood
(ii) sulphite
(iii) kraft
(iv) soda

(*c*) The following data was obtained from the analysis of a sulphite pulp.

Beater time (min.)	0	15	30	45	60
Basis weight (g/m^2)	57	55	60	58	60
Burst factor	13	22	24	23	20
Tear Factor	88	100	86	64	60
Canadian standard freeness (ml.)	700	660	580	430	200

(i) Plot beater curves on the graph-sheet provided by the Presiding Officer.
(ii) From the graph you have drawn, determine the freeness for optimum strength.

14 14. (*a*) Give acceptable names for *each* of the following.

(i) $CH_3CH_2CH_2OH$
(ii) C_2H_4

(*b*) Draw the structural formula for any *two* of the following compounds. Show all atoms and bonds carefully.

(i) butanoic acid (butyric acid)
(ii) ethanal (acetaldehyde)
(iii) 2, 2-dimethylpropane (neopentane)

(*c*) Write fully balanced equations to show any *two* of the following reactions.

(i) the reaction between ethanoic acid (acetic acid) and methanol (methyl alcohol)

$$CH_3COOH + CH_3OH \rightarrow$$

(ii) the complete combustion of an octane

$$C_8H_{18} + O_2 \rightarrow$$

(iii) the main reaction between bromine and propene (propylene)

$$C_3H_6 + Br_2 \rightarrow$$

(*d*) Describe briefly chemical tests which could be used to distinguish between the members of any *two* of the following pairs of compounds.

(i) methanal (formaldehyde) and ethanal (acetaldehyde)
(ii) propanone (dimethyl ketone) and ethanal (acetaldehyde)
(iii) 2-pentanone (methyl propyl ketone) and 3-pentanone (diethyl ketone)

14 15. (*a*) Explain briefly the conditions under which *each* of the following is formed.

(i) matte
(ii) speiss

(*b*) Explain briefly why the formation of *each* of the following is undesirable when assays are being made for gold and silver.

(i) matte
(ii) speiss

(*c*) Rocks may be classified into four types, sedimentary, or metamorphic, or igneous volcanic (extrusive) or igneous plutonic (intrusive). From the following list of rocks select *one* example of each type.

(i) marble
(ii) granite
(iii) shale
(iv) schist
(v) basalt
(vi) obsidian
(vii) sandstone
(viii) gneiss
(ix) gabbro
(x) limestone

(*d*) Describe briefly *one* of the following geological formations and supplement your answer with labelled diagrams.

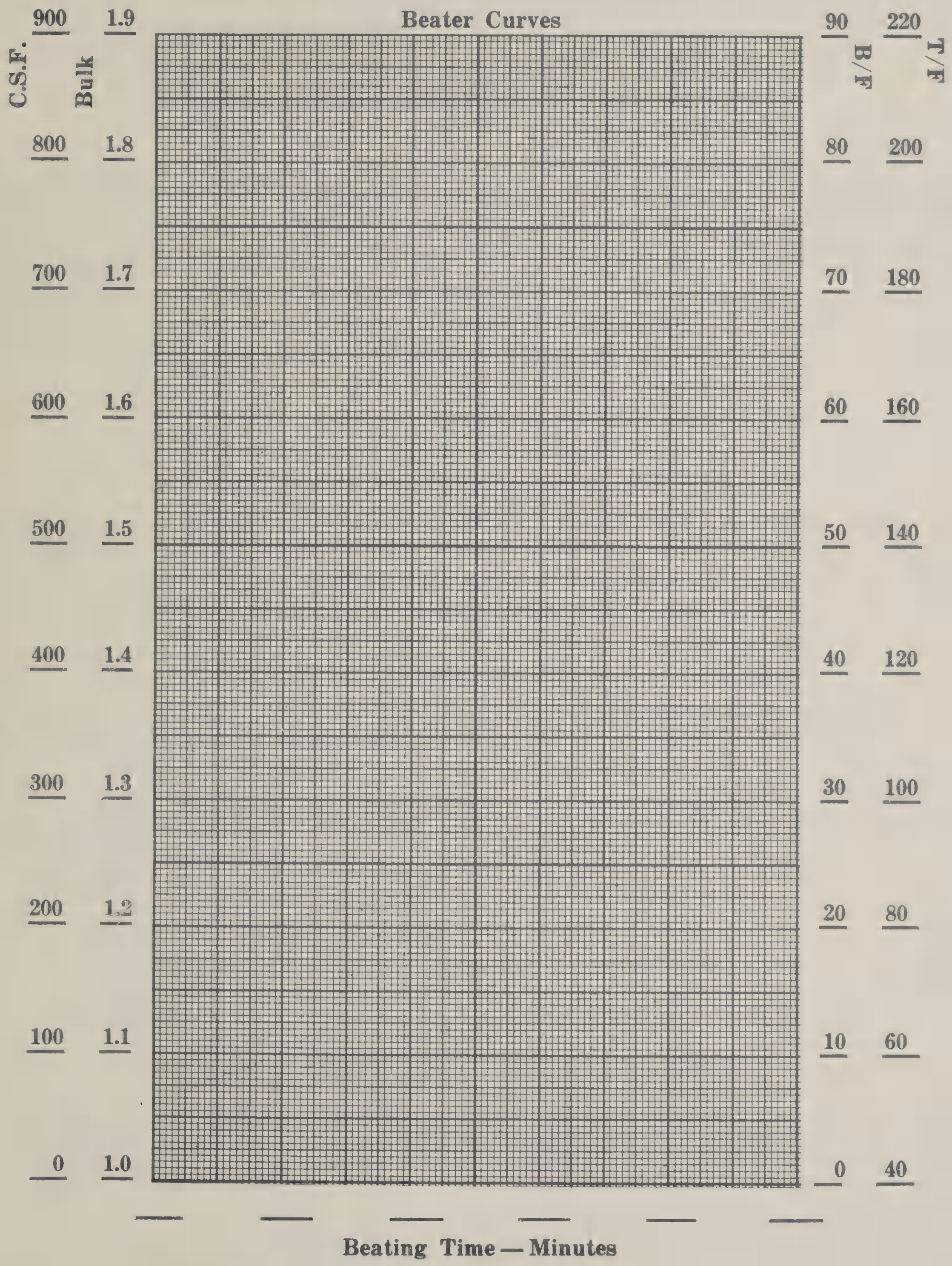
(i) faulting
(ii) folding

TO BE USED IN ANSWERING QUESTION 12.

SOME COMMON MINERALS

	Colour	Hardness	Specific Gravity	Luster	Natural Form	Streak	Cleavage	Tests
(i)	lead-grey	2.5 - 2.7	7.4 - 7.6	metallic	cubic crystal	black	cubic	fuses on charcoal with yellow coating around bead
(ii)	light yellow	6 - 6.5	5.0	metallic	cubic crystals; massive	black	none, brittle	gives SO_2 fumes on heating; insoluble in HCl
(iii)	red or black	1 - 6.5	4.9 - 5.3	earthy or metallic	massive	red	none	becomes magnetic on roasting; soluble in concentrated HCl
(iv)	colourless, white smoky, rose violet, brown	7	2.6	glassy	well formed hexagonal crystals or massive	-	rhombohedral if seen	infusible; insoluble
(v)	reddish-orange	2.5 - 3	8.9	metallic	massive	metallic orange	malleable and ductile	soluble in acids, mainly HNO_3; gives green solutions
(vi)	light yellow	2	2.0-2.1	resinous	orthorhombic and massive	-	brittle	melts at 108°C; burns with a blue flame; insoluble in water or acids but soluble in CS_2
(vii)	yellow to red-brown; black	3.5 - 4	3.9-4.1	resinous to glassy	various complex crystals	-	brittle	practically infusible; dissolves in HCl forming H_2S
(viii)	white to dark red-brown	1-3	2.0 - 2.5	dull earthy	clay-like and massive	-	indeterminate	infusible; insoluble; coloured blue when moistened with cobalt nitrate and heated
(ix)	colourless to white	2.5	2.1 - 2.6	glassy	cubic crystals and massive	-	perfect cubic	water soluble; colours flame yellow; in H_2O forms white ppt. with $AgNO_3$
(x)	colourless to white	2	2.3	glassy, pearly or silky	mainly massive; also monoclinic crystals	-	thin sheets or easily cleaved	becomes hygroscopic after heating; soluble in hot, dilute HCl then forms ppt. with $BaCl_2$

To be used in answering Question 13.



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ONTARIO DEPARTMENT OF EDUCATION

GRADE 12 DEPARTMENTAL EXAMINATIONS, 1967

REFRIGERATION, AIR CONDITIONING AND HEATING

NOTE 1. *The Presiding Officer will place Part A, Part B, and a psychrometric chart to be used in answering Question 2 on your desk at the beginning of the examination period. Part B, to which 28 marks will be allotted, may be answered at any time during the examination period.*

NOTE 2. *Your name and form, and the name of your school are to be written clearly on each examination book and at the top of Part B.*

NOTE 3. *Geometry instruments and slide rules may be used.*

Values

PART A

SECTION I

Answer ALL questions in Section I.

11 1. A heat loss calculation sheet for a small commercial building includes the following data.

wall area 3800 sq. ft., U factor 0.25
roof area 5000 sq. ft., U factor 0.40
floor area 5000 sq. ft., U factor 0.20
window area 400 sq. ft., U factor 1.10
ventilation and infiltration, 900 cfm

Determine the total *sensible* heat loss of the building if the inside design temperature is 70°F and the outside design temperature is 0°F.

9 2. Use the psychrometric chart provided by the Presiding Officer, when answering this question.

(*a*) For air at 85°F DB with 60% RH, find
  (i) the wet-bulb temperature
  (ii) the dew-point temperature
  (iii) the specific humidity (grains per lb.)

(*b*) For air at 72°F DB with a specific humidity of 59 grains per lb., find
  (i) the dew-point temperature
  (ii) the relative humidity

(*c*) For air entering a summer air conditioner at 98°F DB and 75°F WB and leaving at 60°F DB and 45°F WB, find the *total* heat (BTU per lb.) removed by the air conditioner.

9 3. State *three* effects which *each* of the following has on the operation of a belt-driven compressor.

(*a*) a low expansion valve super heat
(*b*) a leaking compressor suction valve
(*c*) the installation of a smaller pulley on the compressor motor

CONTINUED OVER→

Values

SECTION II

Answer EITHER Question 4 OR 5 in Section II.

either

9 4. Describe, the thermostatic expansion valve under *each* of the following headings. (A simple sketch may be used to clarify your answer.)

(*a*) four major *operating* parts

(*b*) principle of operation

or

9 5. Discuss contaminants in a vapour-compression refrigeration system under *each* of the following headings.

(*a*) *two* basic types of contaminants

(*b*) *two* harmful effects of each type of contaminant given in (*a*) on the operation of the system

(*c*) *three* methods of preventing contaminants from entering the system

SECTION III

Answer any TWO Questions in Section III.

9 6. (*a*) Draw a block wiring diagram for *either* a forced air oil-fired furnace *or* a forced air gas-fired furnace. Indicate and label all the major electrical components required.

(*b*) State *three* factors which should be considered when the location for the room thermostat for the above furnace is being determined.

9 7. Draw a labelled block diagram, showing a boiler, three room-heating units, a pump, and supply and return piping for *each* of any *three* of the following types of central heating systems.

(*a*) a single-pipe series system

(*b*) a single-pipe "Monoflo" system

(*c*) a two-pipe direct-return system

(*d*) a two-pipe reverse-return system

(*e*) a two-pipe gravity steam system in which the positions of the condensate return tank and the steam traps are shown.

9 8. (*a*) Name *two* basic methods used in oil burners to prepare the oil for combustion.

(*b*) Describe, the method used in a *high-pressure* oil burner to prepare the oil for combustion.

9 9. (*a*) Explain briefly the meaning of the term, combustion efficiency.

(*b*) Name the *four* tests required to determine the efficiency of an oil-fired furnace.

(*c*) List a set of typical readings obtained when a combustion efficiency test is performed on a domestic oil-fired furnace.

Values

SECTION IV

Answer any TWO questions in Section IV.

8 10. Explain the purpose and the principle of operation of any *two* of the following, as applied to domestic refrigerators. (A sketch may be used as part of each answer.)

(*a*) the capillary line flow control
(*b*) the current relay
(*c*) the air spill-over system
(*d*) the refrigerant spill-over system

8 11. Describe, the hot gas automatic defrost system used for commercial evaporators, under *each* of the following headings. (A sketch may be used as part of your answer.)

(*a*) the equipment required
(*b*) the location of each part of the equipment
(*c*) the theory of operation

8 12. An experienced refrigeration technician is called upon to diagnose the trouble in a faulty commercial refrigeration system.

The system consists of the following components.
— a forced air evaporator
— a thermostatic expansion valve
— an air-cooled condensing unit with a reciprocating compressor
— a low-pressure operating control

The customer reports the following.
— a high refrigerator temperature
— short-cycling of the compressor

Preliminary tests by the technician indicate the following.
— a full liquid line
— a normal operating head pressure
— a low suction pressure

(*a*) Indicate clearly *four* possible defects which could cause the trouble in the system described above.

(*b*) Explain why *each* of the defects given in your answer to (*a*) could cause the trouble.

ONTARIO DEPARTMENT OF EDUCATION

GRADE 12 DEPARTMENTAL EXAMINATIONS, 1967

REFRIGERATION, AIR CONDITIONING AND HEATING

....
NAME

....
FORM

....
NAME OF SCHOOL

PART B

NOTE 1. *Part B has a value of 28 marks and all items are equal in value.*

NOTE 2. *Answers are to be indicated clearly in the answer column at the right.*

— — — —

There are four suggested answers for each of the following incomplete statements. Select the correct response, and circle its *letter* in the answer column at the right.

1. The result of an excess of combustion air is
(A) high CO_2 readings (C) excessive smoke
(B) low CO_2 readings (D) low stack draft

1. A B C D

2. The efficient combustion of oil is independent of
(A) stack temperature (C) combustion chamber size
(B) stack draft (D) ignition voltage

2. A B C D

3. On a two-pipe oil supply system, part of the oil is returned from the pump to the
(A) oil tank (C) nozzle
(B) combustion chamber (D) suction line

3. A B C D

4. A draft hood is needed to protect gas-fired equipment from
(A) downdraft (C) zero draft
(B) excessive heat (D) excessive condensation

4. A B C D

5. The purpose of a limit control on a gas-fired furnace is to prevent
(A) fan operation (C) burner draft
(B) burner operation (D) secondary air

5. A B C D

6. The primary function of a stack relay is to
(A) control the flue temperature
(B) control the temperature of combustion
(C) ensure safe conditions for combustion
(D) regulate stack draft

6. A B C D

7. Silver brazing is used in place of soft soldering because it
(A) is less expensive (C) makes stronger joints
(B) makes neater joints (D) melts at a lower temperature

7. A B C D

8. A leaking needle valve in a low-side float is indicated by a
(A) low head pressure (C) warm liquid line
(B) frosted suction line (D) lack of refrigerant

8. A B C D

9. A person is *most* comfortable in a room at 70°F when the relative humidity is
(A) 5% (B) 15% (C) 45% (D) 70%

9. A B C D

CONTINUED OVER→

10. For most effective summer cooling, air supply grills should be installed

(A) near the ceiling
(B) near the floor
(C) near the wall
(D) near the thermostat

10. A B C D

11. An expansion tank is used in a hydronic heating system to control the effects of

(A) a high boiler-water level
(B) air expansion
(C) boiler corrosion
(D) water expansion

11. A B C D

12. A flooded evaporator is one which is flooded with

(A) secondary refrigerant
(B) refrigerant vapour
(C) refrigerant liquid
(D) air

12. A B C D

13. Copper tubing used in refrigeration systems is normally

(A) Type L (B) Type K (C) Type M (D) Type DWV

13. A B C D

14. Silver brazing is generally performed at a temperature between

(A) 1000°F and 1600°F
(B) 500°F and 1000°F
(C) 1500°F and 1900°F
(D) 2000°F and 2500°F

14. A B C D

15. A house loses 100,000 BTU/hour when the inside temperature is 70°F and the outside temperature is 40°F. The heat loss will be 200,000 BTU/hour when the inside temperature is 70°F and the outside temperature is

(A) +20°F (B) +10°F (C) 0°F (D) −10°F

15. A B C D

16. The specific heat of a substance is expressed in

(A) BTU
(B) BTU per lb.
(C) BTU per degree F
(D) BTU per lb. per degree F

16. A B C D

17. If an ice machine produces 10 pounds of ice per hour from water at 70°F the *latent* heat that must be removed is

(A) 1440 BTU
(B) 800 BTU
(C) 1820 BTU
(D) 9700 BTU

17. A B C D

18. The *saturation* pressure in a refrigerant cylinder

(A) doubles when the temperature of the refrigerant doubles
(B) increases as the quantity of liquid refrigerant increases
(C) depends upon the volume of the cylinder
(D) is independent of the quantity of refrigerant in the cylinder

18. A B C D

19. The U factor for a wall is the reciprocal of the total wall

(A) conductance
(B) resistance
(C) conductivity
(D) specific heat

19. A B C D

20. An automatic expansion valve produces a constant evaporator

(A) pressure
(B) refrigerant level
(C) super heat
(D) cooling

20. A B C D

21. If a capillary line flow control is to work satisfactorily, the system should operate

(A) under constant load
(B) without a receiver
(C) with a critical refrigerant charge
(D) under all of the above conditions

21. A B C D

22. The proper location of the vapour barrier in the wall of a refrigerated room is

(A) on the high temperature side of the wall
(B) on the low temperature side of the wall
(C) in the centre of the insulation
(D) independent of the direction of the heat flow

22. A B C D

23. Refrigerant cylinders should not be used if the date stamped on the cylinder is older than
(A) three years
(B) six months
(C) six years
(D) one year

23.
A B C D

24. A liquid-suction-line heat exchanger tends to
(A) decrease the suction pressure
(B) decrease the suction line temperature
(C) decrease the suction line superheat
(D) increase the suction pressure

24.
A B C D

25. Water can be *most* readily removed from a system if the pressure is reduced to
(A) 29 inches of mercury
(B) 1 inch of mercury
(C) 50 microns, absolute pressure
(D) 500 microns, absolute pressure

25.
A B C D

26. Copper tubing should be filled with nitrogen gas prior to brazing
(A) to lower the brazing temperature
(B) to lessen the scale formation
(C) to increase the strength of the joint
(D) to reduce tubing distortion

26.
A B C D

27. Refrigerant R22 is often used in preference to refrigerant R12 in order to
(A) increase the system capacity
(B) decrease the system head pressure
(C) increase the volumetric efficiency
(D) decrease the suction pressure

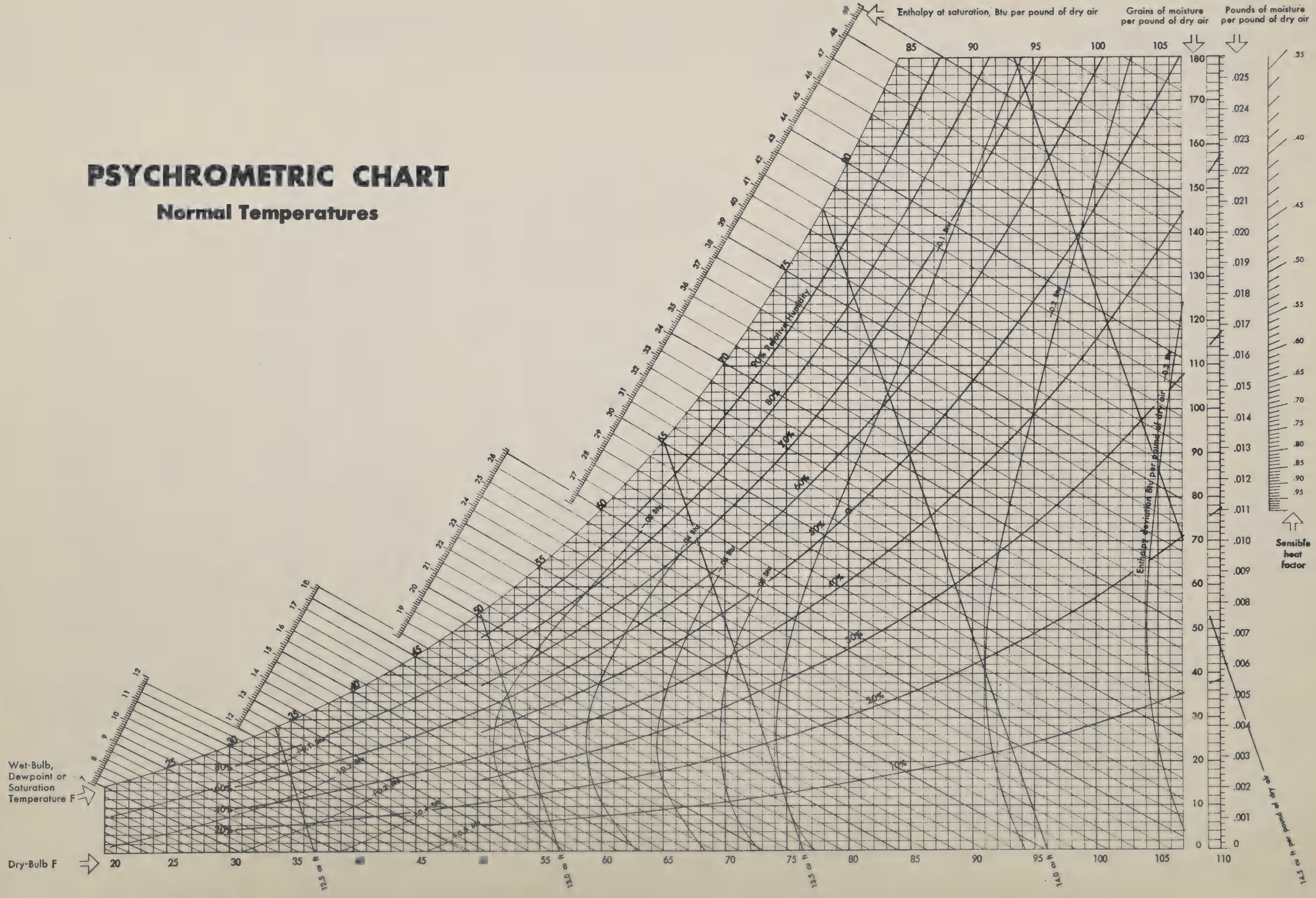
27.
A B C D

28. The maximum safe operating pressure of a residential cast iron hot-water boiler is
(A) 12 psig
(B) 30 psig
(C) 25 psig
(D) 15 psig

28.
A B C D

PSYCHROMETRIC CHART

Normal Temperatures



Below 32 F, properties and enthalpy deviation lines are for ice.

[illegible]

ONTARIO DEPARTMENT OF EDUCATION

GRADE 12 DEPARTMENTAL EXAMINATIONS, 1967

MATHEMATICS

TIME — 2 HOURS

NOTE 1. . . . . *Your name and form, and the name of your school, are to be written clearly on each examination book and on the folder for Part B, which is to be handed in with your examination book.*

NOTE 2. . . . . *The Presiding Officer will provide you with the whole paper, including Part B, at the beginning of the examination period. Part B, to which approximately 30% of the total mark will be allotted, may be answered at any time during the examination period. You are advised to allow approximately 35 minutes for answering Part B.*

NOTE 3. . . . . *You should obtain from the Presiding Officer a set of four-figure or five-figure mathematical tables and the graph paper provided for Question 10(a).*

NOTE 4. . . . . *Since approved texts use different symbols to represent the sets of numbers, for the purpose of this examination ONLY, the symbol N represents the set of natural numbers and the symbol Re represents the set of real numbers. The symbol $\geqq$ is equivalent to the symbol $\geq$, and the symbol $\leqq$ is equivalent to the symbol $\leq$.*

NOTE 5. . . . . *The diagrams printed on the examination paper are not necessarily drawn to scale.*

— — — —

Approximate Percentage Values

PART A

4 1. (*a*) Determine the solution set of

$$\{\, x \mid \frac{x+3}{2} - \frac{x-1}{6} = -2,\ x \in N \,\}.$$

2 (*b*) In your examination book draw, and label completely, a graph on the real number line to represent the following set.

$$\{\, x \mid 8-4x \leqq x-2,\ x \in \mathrm{Re} \}$$

2. Given the points $A(2,3)$, $B(-4,0)$, and $C(-1,y)$ in the Cartesian plane, find

2 (*a*) the equation of the line through A and B in the form $ax+by+c=0$,

2 (*b*) the numerical value of y, such that the point $C(-1,y)$ lies on the line through A and B.

CONTINUED OVER→

Approximate Percentage Values

4 3. (*a*) Evaluate $32^{4/5}+(-6)^0-(\frac{1}{9})^{-1/2}+\sqrt[3]{27^2}$.

4 (*b*) Simplify $\dfrac{8^{x+2}\cdot(16^x)^{x+1}}{(2^{x-1})^2}$.

5 (*c*) Use tables of logarithms to evaluate to 4 significant figures

$$\sqrt{\frac{274.6\times.04360}{16.80}}\ .$$

4. Determine the roots of *each* of the following equations.

2 (*a*) $6x^2-7x-3=0$

3 (*b*) $2\cos^2\theta-3\cos\theta+1=0,\ 0\leqq\theta\leqq\frac{\pi}{2}$

5. Answer *either* (*a*) *or* (*b*).

either

(*a*) Given the quadratic function

$$F=\{(x,\ y)\mid y=30-9x-3x^2,\ x\in\text{Re}\},$$

4 (i) determine the range of the function by the method of completing the square,

2 (ii) determine the intercepts on the coordinate axes,

1 (iii) state the equation of the axis of symmetry,

3 (iv) use the data derived from your answers to (i), (ii), and (iii) to sketch in your examination book, the graph of the function. (*A table of values is not necessary.*)

or

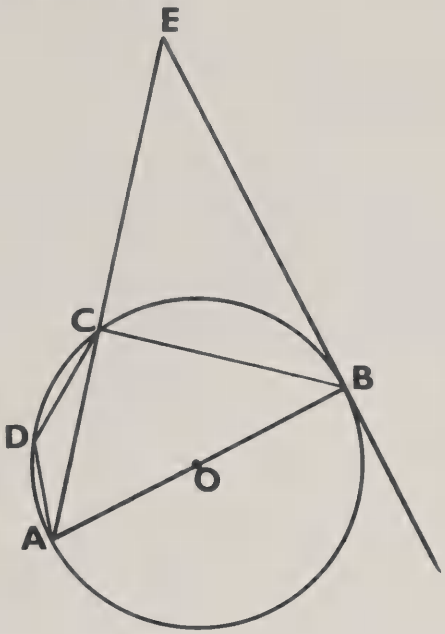
(*b*) A rectangular field is bounded on one side by a river and on the other three sides by an electrified fence. The total length of the electrified fence is 400 yards.

5 (i) Write a quadratic function which describes the area that may be enclosed under the above-stated conditions and the limitations placed on the domain of the function by the conditions of the problem.

3 (ii) Determine the maximum value of the function, and therefore the maximum area that may be enclosed by the fence.

2 (iii) State the dimensions of the field for which the enclosed area is a maximum.

4 6. In the diagram below, $ABCD$ is a cyclic quadrilateral such that the side AOB is a diameter. AC produced meets the tangent drawn at B in the point E. If the measure of the angle at E in degrees is 40, calculate the measure of the angle at D in degrees. All steps in the solution must be shown. (It is not necessary to state authorities and to recopy the diagram.)



6 7. In your examination book *sketch* the region in the Cartesian plane defined by the relation

$$x^2+y^2 > 36,\ x \geqq 1,\ y \leqq 0.$$

8. The equation of a circle is

$$x^2+y^2=49,\ x,\ y \in \text{Re}.$$

2 (*a*) Show that the point $A(4\sqrt{3}, 1)$ lies on this circle.

4 (*b*) A tangent to this circle passes through the point $P(15, 20)$ and touches the circle at a point Q. Calculate the length of the line segment PQ.

9. The fourth and eighth terms of a sequence of *real* numbers are 3 and 243, respectively. Calculate the seventh term if the sequence is

4 (*a*) arithmetic,

5 (*b*) geometric.

CONTINUED OVER→

Approximate Percentage Values

10. Answer *either* (*a*) *or* (*b*).

either

(*a*) On the same set of axes, sketch, on the graph paper provided by the Presiding Officer, the graphs of the following trigonometric functions for the domain $-2\pi \leqq \theta \leqq 2\pi$.

2 (i) $y = \sin \theta$

2 (ii) $y = 2 \sin \theta$

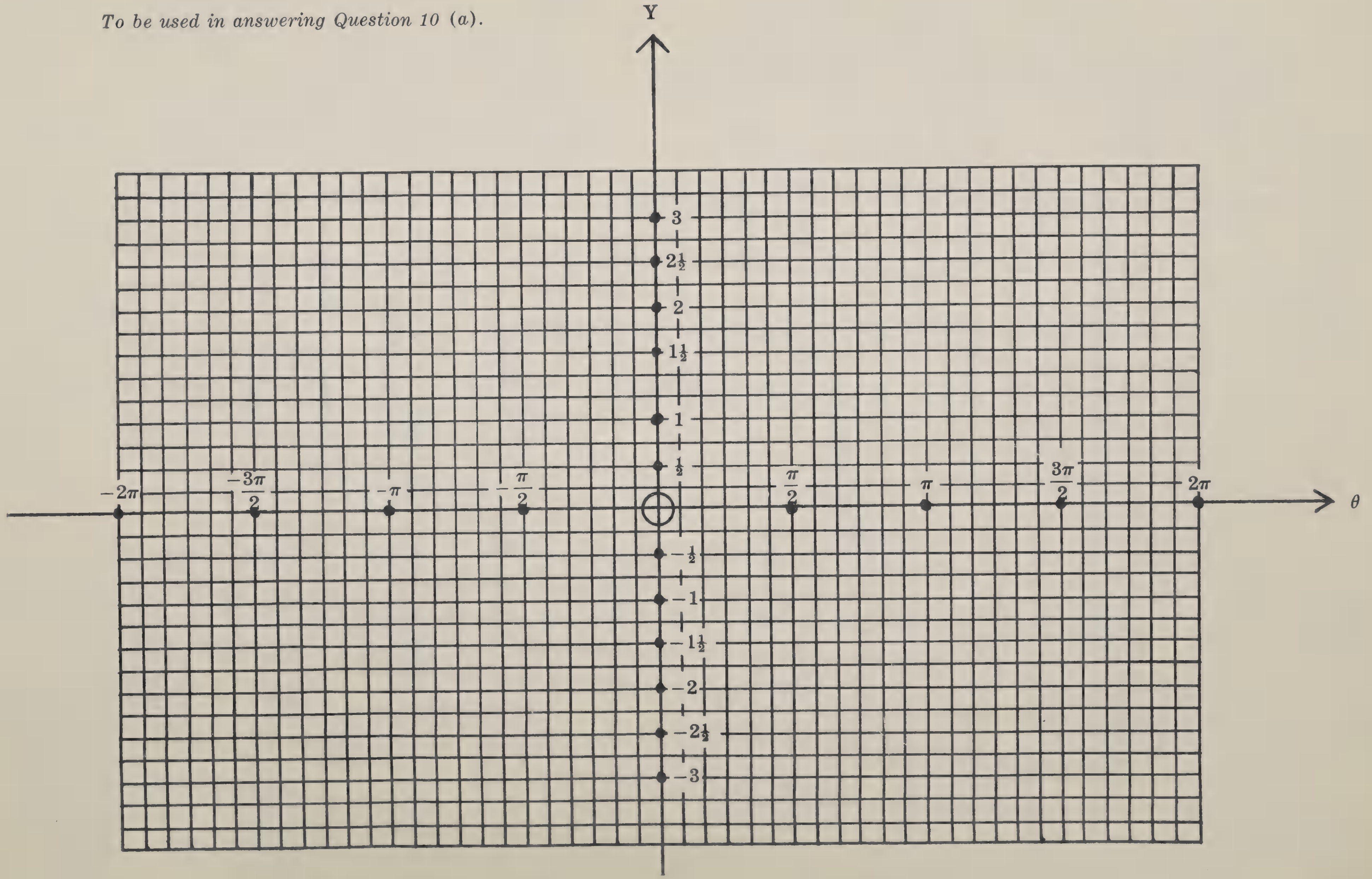
3 (iii) $y = 3 \sin 2\theta$

(NOTE. *Fasten the graph paper to a blank page in your examination book.*)

or

7 (*b*) Point *C* is the base of a flagpole which is situated on level ground. The angle of elevation of the top of the flagpole as observed from a point *A* on the level ground is 14.0 degrees. The angle of elevation from a second point *B*, 300 feet closer to the base of the flagpole and in a line through *A* and *C*, is 28.0 degrees. Calculate the height of the flagpole to the nearest foot.

To be used in answering Question 10 (a).



NAME.................................. FORM.......... SCHOOL.......................

ONTARIO DEPARTMENT OF EDUCATION

GRADE 12 DEPARTMENTAL EXAMINATIONS, 1967

MATHEMATICS

PART B

....
NAME

....
FORM

....
NAME OF SCHOOL

NOTE 1. *All items in Part B are equal in value.*

NOTE 2. *Calculations necessary for Part B may be made in the blank spaces beside the questions, or on an unused left-hand page in the answer book.*

NOTE 3. *Answers are to be indicated clearly in the answer column at the right.*

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There are five suggestions for completing each of the following incomplete statements. Select the correct completion and circle its *letter* in the answer column at the right.

1. The period of the function defined by $y=\frac{3}{2}\sin\frac{x}{2}$, $x \in \text{Re}$ is

(A) $\frac{3}{2}$
(B) $\frac{\pi}{2}$
(C) π
(D) $\frac{1}{2}$
(E) 4π

1.
A B C D E

2. If $F(x)=\frac{2x^2+x}{1-x^3}$, $x \in \text{Re}, x \neq 1$, then $F(-1)$ is

(A) $\frac{1}{4}$
(B) $\frac{-3}{2}$
(C) $\frac{3}{2}$
(D) $\frac{1}{2}$
(E) undefined

2.
A B C D E

3. The y-intercept of the graph of the quadratic function defined by $y=3(x-2)(x+2)+5$, $x \in \text{Re}$ is

(A) -7
(B) -2
(C) 5
(D) 2
(E) $\frac{\sqrt{21}}{3}$

3.
A B C D E

CONTINUED OVER→

4. If the sum of the roots of the quadratic equation

$$2x^2-kx+5=0$$

is 6, then the numerical value of k is

(A) 6
(B) 12
(C) -12
(D) $\frac{1}{3}$
(E) $\frac{5}{2}$

4.

A B C D E

5. A tangent touches a circle at the point $P(5, -4)$. If the equation of the circle is $x^2+y^2=41$, then the slope of the tangent is

(A) $-\frac{4}{5}$
(B) $-\frac{5}{4}$
(C) $\frac{4}{5}$
(D) $\frac{5}{4}$
(E) undefined

5.

A B C D E

6. The quadratic equation for which the roots are $3-2\sqrt{2}$ and $3+2\sqrt{2}$ may be written in the form

(A) $8x^2+6x+1=0$
(B) $x^2-6x+5=0$
(C) $x^2-6x+1=0$
(D) $x^2+6x-4\sqrt{2}=0$
(E) $x^2-6x-1=0$

6.

A B C D E

7. If $x=2$, $y=3$, then the numerical value of $\frac{2x^{-1}}{3y^{-2}}$ is

(A) 3
(B) $\frac{27}{4}$
(C) $\frac{81}{4}$
(D) 9
(E) 6

7.

A B C D E

8. The relations P, Q, R, and S are defined by the following sets of ordered pairs.

$P=\{(2, 1), (4, 2), (6, 3)\}$
$Q=\{(4, 5), (1, 7), (6, 3), (4, 1)\}$
$R=\{(3, 2), (4, 2), (5, 4), (6, 4)\}$
$S=\{(-2, 7), (-1, 6), (0, 5), (-1, 4)\}$

Of these relations only the following are functions.

(A) P
(B) Q and S
(C) P and R
(D) R and S
(E) P, Q, R, and S

8.

A B C D E

9. Log $ab+\log\frac{a}{b}-\log a^2$, where $a, b \neq 0$, is equivalent to

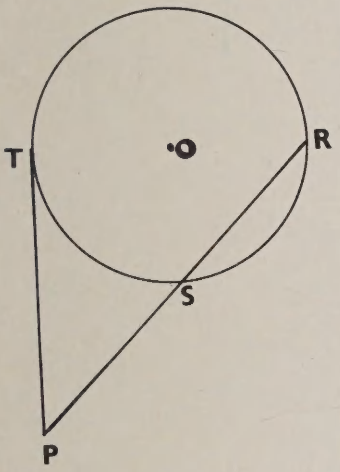
(A) $\log a^4$
(B) $\log\frac{a^4}{b^4}$
(C) 0
(D) 1
(E) $-a^4$

9.
A B C D E

10. Given the equation $4^x+4^{x-1}=40$, $x \in \text{Re}$, the solution set is

(A) $\{2\}$
(B) $\{5\frac{1}{2}\}$
(C) $\{3\frac{1}{2}\}$
(D) ϕ
(E) $\{2\frac{1}{2}\}$

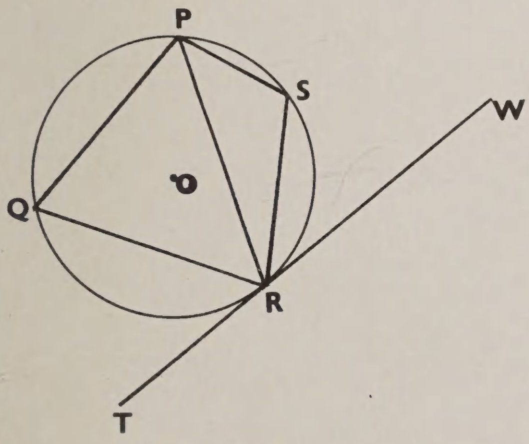
10.
A B C D E



11. In the diagram at the left, a tangent *PT* and a secant *PSR* are drawn to a circle, centre *O*. If the measure of the length of *SR* is 3 and *PS* is 4, then the measure of the length of *PT* is

(A) $2\sqrt{3}$
(B) $\sqrt{21}$
(C) $\sqrt{7}$
(D) $2\sqrt{7}$
(E) 5

11.
A B C D E



12. In the diagram at the left, *TRW* is a segment of a tangent which touches a circle, centre *O*, at *R*. If the measure of angle *PRW* in degrees is 74 and of angle *QRP* is 47, then the measure of angle *QSR* in degrees is

(A) 59
(B) 37
(C) 47
(D) 74
(E) 106

12.
A B C D E

13. If the sides of a triangle have lengths of $\sqrt{8}$ in., $\sqrt{2}$ in., and $\sqrt{6}$ in., then the angle opposite the side whose length is $\sqrt{6}$ in. is an angle whose

(A) sine is $\frac{1}{2}$
(B) tangent is undefined
(C) measure in degrees is 60
(D) cosine is 1
(E) measure in degrees is 30

13.
A B C D E

CONTINUED OVER→

14. Given that the sum of the first n terms of a sequence is n^2+6n, then the fifth term of the sequence is

(A) 55
(B) 40
(C) 17
(D) 15
(E) 30

14.

A B C D E

15. If a sequence is defined recursively as

$$t_1=2,\ t_2=3,\ t_n=2t_{n-1}+t_{n-2},\ n>2,$$

where t_n means the nth term of the sequence, then the fourth term is

(A) 5
(B) 8
(C) 13
(D) 17
(E) 19

15.

A B C D E